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AN ANNOTATED BIBLIOGRAPHY OF COTTON RESEARCH AT THE SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

Miscellaneous Publication No. 893

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

For purposes of research by the U.S. Department of Agriculture on utilization of agricultural crops, the country has been divided into four regions. Each region is served by a Utilization Research and Development Division of the Agricultural Research Service. The southern area includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, and Texas. Headquarters for the Division are located at:

Southern Regional Research Laboratory
1100 Robert E. Lee Boulevard
New Orleans, La.

This laboratory conducts research on utilization of cotton, cottonseed, rice, tung, peanuts and other oilseeds, sugarcane and sugarcane products, and sweetpotatoes, and on fundamental chemistry and process engineering and development applicable to utilization of these crops. Five field stations in the Division are located near sources of supply of the raw materials being studied, including citrus and other subtropical fruits, pine gum and its derivatives, and cucumbers and miscellaneous southern-grown vegetables. These field stations are:

U.S. Sugarcane Products Laboratory, Houma, La.
Naval Stores Station, Olustee, Fla.
U.S. Fruit and Vegetable Products Laboratory, Winter Haven, Fla.
U.S. Food Fermentation Laboratory, Raleigh, N.C.
U.S. Fruit and Vegetable Products Laboratory, Weslaco, Tex.

For information on any of the lines of research being conducted in the Southern Utilization Research and Development Division, you are invited to write or visit the Southern Regional Research Laboratory, or the field station immediately concerned with the product in which you are interested.

AN ANNOTATED BIBLIOGRAPHY OF COTTON RESEARCH AT THE SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

By Marie A. Jones
Southern Utilization Research and Development Division
Agricultural Research Service

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

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FOREWORD

COTTON—OLD FIBER WITH A NEW FUTURE

Some fifty centuries ago, cotton appeared on the textile scene and entered into competition with silk and wool. During the ensuing 5,000 years, cotton, by virtue of its native good qualities, advanced until for more than a century it has been the world's leading fiber.

Cotton supplies approximately two-thirds of the textile needs of the United States, and it is an important factor in the national economy. As agriculture is this country's biggest industry, so cotton is the biggest single cash crop.

Another gage of its importance is the fact that 12 million people depend directly on the cotton industry for their livelihood, through income from cotton growing, ginning, warehousing, merchandising, seed crushing, spinning, weaving, and apparel manufacturing. To this number can be added an estimated 13 million more who derive a sizable part of their living less directly from cotton through the wholesaling and retailing of cotton products and from machinery manufacturing, banking, transportation, and other enterprises.

After such a long history of use and such prodigious development, it might seem that cotton has reached its peak of usefulness and popularity. This is not true. Although cotton has lost ground in some important markets in recent years, a revitalized cotton industry has aroused itself to meet the challenges of science and technology and to make sure gains notable for their promise of future progress.

In 1938, when Congress authorized establishment of the four regional laboratories of the U.S. Department of Agriculture, interest in research on the utilization of cotton, as of other farm commodities, was just beginning to gain momentum. World War II soon began and absorbed the Nation's entire energy, but with the end of hostilities came the release of a tremendous store of scientific developments for peacetime uses.

Growing competition inspired a burst of activity in all areas of the cotton industry. Aggressive merchandising recalled to the attention of consumers the native good qualities of cotton, long taken for granted. Textile designers produced cotton fabrics in new and beautiful weaves, colors, and patterns. Leading stylists took these fabrics as material for their talents, putting cotton in the front rank for glamour, and proving it suitable for winter as well as summer wear.

The greatest innovations, however, and the greatest benefits, came in the field of research. Many textile manufacturers and finishers initiated research programs of their own. Universities and State and private research organizations intensified their efforts to learn more about the properties and the fundamental structure and chemistry of the cotton fiber, and to find ways of making better cotton products.

This active program of cotton utilization research, less than two decades old and still gaining in intensity, has already brought a great many important developments. Some of these have been adopted commercially with the result that cotton has not only regained ground lost, but has gone on to make some gains prophetic of still further progress. Other developments still in the laboratory, in the pilot plant, or on the engineer's drawing board can be expected to follow these earlier discoveries and to be put into commercial use to further strengthen cotton's position.

Cotton utilization research at the Southern Division began with the opening of the Southern Regional Research Laboratory and is directed along three closely related lines: Fundamental studies; mechanical processing and machinery development; and chemical treatment and modification.

Knowledge of the fundamental nature of the cotton fiber—its properties, structure, chemical composition, and behavior—is basic to any form of utilization research. Southern Division scientists have done extensive work in the field of fundamental research and have made some real contributions to scientific knowledge of the cotton fiber and its possibilities. Investigations of this kind are being continued and intensified.

Textile engineers and physicists at the Southern Division have developed extensive data on the effect of length distribution, strength, fineness, maturity, and elongation of cotton fibers on yarn and fabric properties and on spinning efficiency. This information has proved extremely useful in guiding cotton spinners in selecting and blending cottons that more nearly meet their requirements and in guiding breeders in developing strains that are more competitive with manmade fibers.

Researchers at the Southern Division have also helped to overcome the difficulties of handling machine-harvested and other trash-laden cotton in textile mills by the invention and development of improved cleaning machines. The Granular Card, which operates efficiently with less loss of fibers, is their most recent contribution to more efficient mill operation. Another aid to more efficient textile manufacturing operations is the accumulation of data on the effect of draft distribution at the various processing steps, which has provided for quick determination of the drafting organizations required for maximum product uniformity and processing efficiency.

In the field of chemical modification, the Southern Division can claim many accomplishments. Chemical modification can be described as the production of new fibers by reacting a compound or compounds with the cellulose of the cotton itself so as to retain the good qualities of the native fiber while adding properties that enhance its value for some specific use. Wash-wear cotton fabrics, the outgrowth of work by many research organizations both here and abroad, is the most spectacular product resulting from these chemical modifications, in that it has been most widely adopted commercially. Research workers at the Southern Division have contributed greatly to wash-wear information, and they are extremely active along other lines, also.

Semielastic cotton gauze bandages and the "stretch" diapers now on the market, as well as other commercially available cotton products, are manufactured by processes based on developments at the Southern Regional Research Laboratory. Developments now in the laboratory stage, or approaching commercial evaluation, are a treatment that makes cotton so highly resistant to flame that, although it chars in intense heat, damage ceases when the heat is removed; one that gives a high degree of mildew and rot resistance; another that imparts similar repellency to oil; and a great many others that add specific properties to cotton that it never had before.

These and many other developments are reported in this compilation of technical publications. The research information published in these papers comprises the significant contribution the Division has made toward opening bright new prospects for cotton.

Important as these contributions are, however, the Southern Division is not alone in the effort to better cotton's position through the application of science and technology. Many other research organizations have made and will continue to make their own great contributions to the advancement of cotton's cause in this Age of Technology.

Judging by the great progress already made through cotton utilization research, it seems safe to predict that cotton is truly a fiber with a future.

C. H. FISHER, *Director,*
Southern Utilization Research
and Development Division.

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AN ANNOTATED BIBLIOGRAPHY OF COTTON RESEARCH AT THE SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

By MARIE A. JONES, *Southern Utilization Research and Development Division, Agricultural Research Service*

Assembled here for the first time in one publication is a compilation of all publications reporting results of cotton research at the Southern Regional Research Laboratory from the time of its opening in 1941 through December 1959.

To supplement the coverage, patents allowed on research findings have been included in a separate section. These patents are available for licensing in the United States of America on a nonexclusive, royalty-free basis.

Arrangement and indexing of the mass of varied information included in the nearly 800 abstracts presented some peculiar problems. It was felt that, for convenience, related material should be brought together; but many of the articles contain information applicable to more than one area of research. The table of contents gives a broad outline of the major categories. The detailed subject index is intended to facilitate the location of the specific information desired.

No attempt has been made to index the articles under the "general" classification, for these are reviews of the broad research program touching on a wide range of subjects rather than giving specific, detailed information on any one subject.

Both subject and author index entries are listed by page number. Numbers assigned to the various titles are the numbers given them in the Southern Division's permanent filing system. These numbers may be used in ordering reprints.

Reprints of most of the papers are available, and single copies will be furnished without cost. Address requests to:

Southern Utilization Research and Development Division
Agricultural Research Service
U.S. Department of Agriculture
P.O. Box 19687
New Orleans 19, La.

We are unable to furnish copies of patents; however, copies may be purchased at 25 cents each from:

Patent Office
U.S. Department of Commerce
Washington 25, D.C.

Literature citations follow the form accepted by the American Chemical Society because members of this society will constitute the majority of users of this compilation.

Organizational names of the U.S. Department of Agriculture agencies used in the abstracts are those that appeared in the published articles.

FIBER STUDIES

Composition

920. MOLECULAR WEIGHT UNIFORMITY OF CELLULOSE AND CELLULOSE DERIVATIVES. RECENT DEVELOPMENT IN MEASUREMENT. Conrad, C. M. Ind. Eng. Chem. *45:* 2511–17. 1953.

There has been continuous development in methods for measuring molecular weight uniformity. Recent studies have shown superiority of precipitation fractionation over solution techniques and have emphasized the importance of proper choice of solvent and precipitant. New methods include electron microscopy, chromatographic adsorption, turbidity, streaming birefringence, coacervation fractionation, resinographic replica, and dielectric dispersion. Recent methods are concerned with quick approximations for securing the distribution curve, application of automatic or semiautomatic devices for tracing the curve, and improved mathematical techniques for expressing results.

704. **COLORIMETRIC DETERMINATION OF THE pH OF COTTON FIBER.** Pons, W. A., Jr.; and Hoffpauir, C. L. Textile Research J. *22:* 200–2. 1952.

A colorimetric method for the determination of the pH of cotton fiber, involving the direct application of neutralized sulfonphthalein indicators dissolved in 25 percent isopropyl alcohol to the fiber, gives a close approximation of the actual pH of cotton fiber. The pH is determined by reference to color standards prepared from buffered cottons containing the same relative amounts of cotton and indicator solution.

784. **COTTON'S MINOR CONSTITUENTS—THEIR ROLE IN UTILIZATION.** Hoffpauir, C. L. Textile Ind. *116* (8) : 109–13. 1952.

Cellulose accounts for 88 to 98 percent of the dry weight of raw cotton. Noncellulosic constituents include wax, protein, salts of inorganic and organic acids, pectic acid, and sugars. The presence of these substances affects the properties of the fiber in relation to mechanical processing, as well as the properties of the finished goods. Their removal by finishing operations is usually necessary to obtain the most satisfactory end-use products.

789. **MORPHOLOGY AND CHEMICAL COMPOSITION OF CERTAIN COMPONENTS OF COTTON FIBER CELL WALL.** Tripp, V. W.; and Rollins, M. L. Anal. Chem. *24:* 1721–28. 1952.

By mechanical beating or differential solution, the primary wall (with cuticle), winding, and lumen contents of the cotton fiber were isolated. The light microscope, with polarizing attachments, was used to locate and characterize these components; the electron microscope was used to observe structure. Limited qualitative and quantitative chemical analyses were carried out. The primary wall consists of a felted network of cellulose fibrils about 200 A. in diameter, embedded in a matrix of pectic, nitrogenous, and waxy substances. Mineral matter and cutin occur in traces. The winding appears to be cellulose; its organization is fibrillar, of a pattern differing from that of the primary or secondary wall. Lumen contents, the protoplasmic remains, contain considerable protein; though tubular in form, no organized fine structure was discerned.

624.1. **SOME OBSERVATIONS ON THE CONSTITUTION OF THE PRIMARY WALL OF THE COTTON FIBER.** Tripp, V. W.; Moore, A. T.; and Rollins, M. L. Textile Research J. *21:* 886–94. 1951.

The primary wall of fully matured cotton fibers has been isolated and its morphology and composition studied by the electron microscope and by chemical analyses. The primary wall appears to consist of about 50 percent cellulose; protein, wax, and pectic substances occur in lesser amounts. Cutin or suberin and mineral matter are also present. The concentration of noncellulosic substances in the primary wall is much greater than it is in the whole fiber. The primary wall under the electron microscope appears to consist of a network of cellulose fibrils having diameters of from 100 to 400 A., surrounded by the noncellulosic constituents. Layers in the cellulose network have been observed.

534. **CHEMICAL COMPOSITION OF COTTON.** McCall, E. R.; and Jurgens, J. F. Textile Research J. *21:* 19–21. 1951.

The fiber properties of six samples of cotton are tabulated and chemical analysis reported for the following: Cellulose, total and reducing sugars, nitrogen, wax, ash, ash alkalinity, pH of the water extract, water extractables, total organic acids, and malic, citric, and pectic acids. There is a rough correlation between the content of organic acids and the ash alkalinity and between ash and water extractables. Where the ash alkalinity exceeds the sum of the organic acids and pectic acid, the pH of the water extract is high. Rain and other weathering factors, including molds, have a profound effect on the organic acid content. A complete chemical analysis of the ash from two of the cotton samples indicated that the major metal present is potassium. There are appreciable quantities of magnesium and calcium and smaller amounts of sodium, iron, and aluminum. Acid constituents included carbonate, sulfate, phosphate, chloride, and silicate.

518. **THE ELECTROPHORETIC MIGRATION OF CELLULOSE IN CUPRIETHYLENEDIAMINE SOLUTION.** Adams, M. E.; Karon, M. L.; and Reeves, R. E. J. Am. Chem. Soc. *73:* 2350–51. 1951.

By substituting copper plates for the silver-silver chloride electrodes, the Tiselius electrophoresis apparatus has been adapted to the observation of the migration of cellulose dissolved in cupriethylenediamine solution. Cellulose migrates toward the anode; the ascending boundaries remain sharp and unresolved, while the descending boundaries separate into distinguishable peaks. The pattern of the descending boundaries appears to be characteristic of the dissolved cellulose.

479. **DEMONSTRATION OF THE PRESENCE OF A GALACTO-ARABAN IN RAW COTTON FIBER.** Guthrie, J. D.; and Reeves, W. A. Textile Research J. *20:* 859–61. 1950.

When an aqueous extract of raw cotton fiber was deionized, evaporated under reduced pressure, and precipitated with ethanol, the precipitated material contained a galacto-araban, since galactose and arabinose were the principal sugars in the hydrolyzate, as was demonstrated by paper chromatography. Galactose was verified by formation of mucic acid and arabinose by formation of its diphenyl-hydrazone. The derivatives were identified by their X-ray diffraction patterns.

480. **TRACE METALS IN COTTON FIBER.** Heinzelman, D. C.; and O'Connor, R. T. Textile Research J. *20:* 805–7. 1950.

A spectrochemical method based on the line-width technique was devised in order to provide compositional data on the presence in cotton of trace metals that are known to catalyze the degradation of cellulose. The method was applied to the cotton lint of 8 varieties grown in 1 location and to 1 variety grown in 13 locations. Its precision and accuracy were tested. Calculated on a moisture-free basis, the highest, lowest, and average parts per million for copper were 4.01, 0.68, and 1.57; for iron, 15.77, 5.74, and 9.03; and for manganese, 12.39, 2.79, and 6.92. Though some variation is attributed to varietal characteristics, greater variation is caused by soil environment. The spectrograms indicated the presence of traces of aluminum, boron, and zinc, but did not reveal the presence of chromium, nickel, or tin.

474. **DETERMINATION OF PECTIC SUBSTANCES IN COTTON. COLORIMETRIC REACTION WITH CARBAZOLE.** Stark, S. M., Jr. Anal. Chem. *22:* 1158–60. 1950.

A colorimetric method for determining pectic materials in cotton is described. It involves the extraction of the pectic materials with sulfuric acid and reaction with an alcoholic solution of carbazole to give color. A quantitative value is obtained by photometric comparison of the color developed by the sample with that of a series of standards made with galacturonic acid monohydrate. The result is expressed as percentage of anhydro-galacturonic acid, the basic group in the pectic polyuronide.

512. **COTTON POWDER FOR INFRARED TRANSMISSION MEASUREMENTS.** Forziati, F. H.; Stone, W. K.; Rowen, J. W.; and Appel, W. D. J. Research, Natl. Bur. Standards *45:* 109–13 (Research Paper 2116). 1950.

Cotton cut in a Wiley mill to pass a 20-mesh screen was ground in a vibratory ball mill. Contamination of the cotton was practically eliminated by using a chromium-plated hardened steel jar and chromium alloy balls. The jar holder is held by a slip ring instead of being bolted in place. The jar and holder automatically rotate slowly on their axis, and this motion counteracts the tendency of the cotton in the jar to settle and grind nonuniformly. The jar is cooled by blowing air over it until it is barely warm to the touch. Five grams of dried cotton disintegrated rapidly during the first 15 minutes of milling. The largest particles remaining after 30 minutes of milling were about 10 microns in major dimension, and there was little reduction of the maximum size with longer milling. Cuprammonium fluidity increased rapidly in the first hour of milling and more gradually thereafter. The carboxyl content increased slowly and reached only about 0.2 percent after 8 hours. The moisture regain of the cotton at 65 percent relative humidity at 21° C. increased rapidly during the first hour of milling from 7.1 to 12.5 percent, and then remained practically constant. X-ray diffraction measurements showed that the cellulose was converted almost completely to the amorphous form in 30 minutes, and that it underwent little change thereafter. The powdered cotton was mulled in mineral oil. The resulting paste was injected into rock salt cells for infrared absorption measurements. No significant differences in infrared absorption were found among a regenerated cellulose film, cotton ground in a Wiley mill to 200 mesh, and cotton ground in the vibratory ball mill for periods of time from 15 minutes to 8 hours.

375. **DETERMINATION OF CELLULOSE BY ACID-DICHROMATE OXIDATION.** Segal, Leon; Tripp, R. C.; Tripp, V. W.; and Conrad, C. M. Anal. Chem. *21:* 712–18. 1949.

A study of the technique of Kettering and Conrad for the volumetric acid-dichromate determination of cellulose in cotton fiber, made with a view to accounting for the lower than theoretical cellulose values obtained, permitted the following conclusions: From 0.5 to 0.6 percent of moisture, depending on the atmospheric condition of the room, is retained in cotton samples dried to constant weight in an air oven at 103° to 110° C. Acid-dichromate oxidation fails to convert all the cellulose (or dextrose or sucrose) into carbon dioxide and water. The amount of ash- and moisture-free cellulose accounted for is only 98.33 percent of the theory. Carbon monoxide is formed during the acid-dichromate oxidation of the cellulose and in the usual technique escapes into the air. The amount of cellulose "lost" in this way amounts to 1.66 percent. Acetic acid is not a product of the acid-dichromate oxidation of cellulose. Accurate cellulose analysis can be accomplished by use of an experimental milliequivalent weight, 6.861 mg., based on the observed relative amounts of carbon monoxide and carbon dioxide formed during the acid-dichromate oxidation.

383. **DETERMINATION OF WAX CONTENT OF RAW COTTON FIBER. NONVALIDITY OF PRELIMINARY TREATMENT WITH HYDROCHLORIC ACID.** Lesslie, Claire; Hagan, Lamont; and Guthrie, J. D. Anal. Chem. *21:* 190–91. 1949.

From data assembled on samples of cotton given various treatments prior to the extraction of wax, the authors conclude that preliminary treatment with hydrochloric acid renders the results inaccurate. The acid converts a water-soluble substance or substances to a material that behaves like wax and makes wax value too high. The nature of these water-soluble substances is unknown. Their behavior is similar to that exhibited by fructose when introduced into purified cotton linters; but the sugar content of raw cotton fiber is not large enough to explain all the increase produced by hydrochloric acid treatments.

80. **SURVEY OF THE CHEMICAL COMPOSITION OF COTTON FIBERS, COTTONSEED, PEANUTS, AND SWEETPOTATOES. A LITERATURE REVIEW.** Guthrie, J. D.; Hoffpauir, C. L.; Stansbury, M. F.; and Reeves, W. A. U.S. Dept. Agr., Bur. Agr. Ind. Chem. Mimeo. Circ. AIC–61 (Rev.), 116 pp. 1949.

This survey is a revision of a similar review published in 1944 and has a twofold purpose: (1) To present available information about the composition of cotton fibers, cottonseeds, peanuts, and sweetpotatoes in a convenient and useful form; and (2) to show where knowledge of the composition of these commodities is inadequate or lacking. An attempt has been made to include information on all substances reported to be present in the commodities except where later literature has shown the substances to be absent or incorrectly identified. References include 85 on cotton fibers, 119 on cottonseed, 134 on peanuts, and 94 on sweetpotatoes.

337. **THE ORGANIC ACID CONTENT OF VARIOUS SAMPLES OF RAW COTTON FIBER IN RELATION TO ASH ALKALINITY AND LEACHING BY RAIN.** McCall, E. R.; Cirino, V. O.; Stark, S. M., Jr.; and Guthrie, J. D. Science *108:* 360–61. 1948.

A number of samples of raw cotton fiber of different varieties, grown in different places, were analyzed for citric acid, *l*-malic acid, pectic acid, total organic acids, ash alkalinity, moisture, and pH. The resulting data show that raw cotton fibers vary greatly in their content of organic acids, but the variation seems to be due more to environmental factors than to the variety of cotton. Rain and other weathering factors apparently have a profound effect on the content of organic acids, especially of *l*-malic acid. A rough correlation was found between the content of organic acids and the ash alkalinity in the samples analyzed.

211. **SOLVENT EXTRACTION OF COTTON WAX.** Kettering, J. H.; Goldthwait, C. F.; and Kraemer, R. M. Textile Research J. *16:* 627–35. 1946.

Different solvents extracted widely different amounts of waxy materials from cottons in experiments where quantity of solvent and sample, rate and total time of extraction, and other laboratory conditions were held constant. The Conrad technique used with either ethyl or isopropyl alcohol was more efficient than any other technique tried. A 6-hour extraction period was found to be adequate for comparative purposes. Trichloroethylene proved to be an unsuitable solvent. Ethyl alcohol, chloroform, carbon tetrachloride, and benzene, in the order named, were increasingly harmful to cotton cloth in a 100-hour extraction experiment. Even in that length of time, these solvents produced only slight degradation in the extracted fabrics and may be safely used in Soxhlet extraction.

179. **ISOPROPYL ALCOHOL IN COTTON WAX DETERMINATION.** Kettering, J. H. Ind. Eng. Chem., Anal. Ed. *18:* 275. 1946.

Replacing ethyl alcohol with isopropyl alcohol, which is cheaper and more readily available, as extracting solvent in the Conrad method for the determination of wax in cotton fiber, does not alter the values obtained.

132. **THE ORGANIC ACID CONTENT OF RAW COTTON FIBER. ISOLATION OF *l*-MALIC ACID AND CITRIC ACID FROM COTTON FIBER.** McCall, E. R.; and Guthrie, J. D. J. Am. Chem. Soc. *67:* 2220–21. 1945.

Raw cotton fiber was analyzed for malic, citric, oxalic, and total organic acids. The analyses showed about 0.5 percent *l*-malic acid and 0.07 percent citric acid. Isolation of these acids in crystalline form definitely established their presence in raw cotton fiber.

69. **DETERMINATION OF SMALL AMOUNTS OF SULFATE IN CELLULOSE NITRATE AND OTHER ESTERS.** Hoffpauir, C. L.; and Guthrie, J. D. Ind. Eng. Chem., Anal. Ed. *16:* 391–92. 1944.

A method has been developed for determining small amounts of sulfate in cellulose nitrate and other cellulose esters; it has proved convenient and gives reproducible results. It involves the decomposition of the cellulose nitrate with nitric acid to which a small amount of perchloric acid is added after the initial stages of digestion. The sulfate in the digest is determined by a modification of the Morgulus and Hemphill method. Barium chromate dissolved in dilute hydrochloric acid reacts with sulfate ions to give a precipitate of barium chromate and an equivalent amount of chromic acid that can be determined iodometrically after the excess barium chromate is precipitated by making the solution alkaline with ammonia. The procedure determines total sulfur, but it is assumed that all the sulfur in cellulose esters is present as sulfate.

45. **DETERMINATION OF THE pH OF TEXTILE MATERIALS.** Wakeham, H. R. R.; and Skau, E. L. Ind. Eng. Chem., Anal. Ed. *15:* 616–18. 1943.

In all previously published methods for the determination of the pH of leather, paper, and textiles, a single-extraction operation has been used on the assumption that the amount of water per unit weight of sample is relatively insignificant. The results of the present investigation, however, show that for textiles the pH of the extract solution is a function of the quantity of water used in the extraction process. An extrapolation method based on this fact is described for the determination of the pH of a fabric. The pH of a textile is defined as the pH of the water present in the cloth under A.S.T.M. standard conditions of temperatures and humidity.

Structure

1889. **DEVELOPMENT AND COMPARISON OF TWO X-RAY METHODS FOR DETERMINING THE CRYSTALLINITY OF COTTON CELLULOSE.** Wakelin, J. H.: Virgin, H. S.; and Crystal, Eugene. J. Appl. Phys. *30:* 1654–62. 1959.

Two X-ray methods have been developed for determining the crystallinity of cellulose by use of a Geiger counter spectrometer. The two methods were applied to six native cotton varieties, to a crossbred variety, and to two cottons chemically modified with ethylamine. The X-ray scattering curves for each of the nine samples were compared with those from a highly crystalline sample, a cotton hydrolyzed in hydrochloric acid, and an amorphous cotton sample to provide a relative measure of crystallinity, or crystalline index. With fully corrected data, the average crystalline index of the six cotton varieties was found to be 68.3 and 78.7 percent by the correlation and the integral methods, respectively. The crystalline indices of the remaining samples, determined by the correlation and by the integral methods are, respectively, crossbred cotton (S X P). 54.3 and 77.2 percent; cotton treated with anhydrous ethylamine, 29.7 and 50.9 percent; and cotton treated with 75 percent aqueous ethylamine, 28.3 and 50.3 percent.

1815. **AN EMPIRICAL METHOD FOR ESTIMATING THE DEGREE OF CRYSTALLINITY OF NATIVE CELLULOSE USING THE X-RAY DIFFRACTOMETER.** Segal, Leon; Creely, J. J.; Martin, A. E.; and Conrad, C. M. Textile Research J. *29:* 786–94. 1959.

An empirical method for determining the crystallinity of native cellulose was studied with an X-ray diffractometer using the focusing and transmission techniques. The influence of fluctuations in the primary radiation and in the counting and recording processes has been determined. The intensity of the 002 interference and the amorphous scatter at $2\theta = 18°$ was measured. The percentage of crystalline material in the total cellulose was expressed by an X-ray "crystallinity index." This was done for cotton cellulose decrystallized with aqueous solutions containing from 70 percent to nominally 100 percent of ethylamine. The X-ray "crystallinity index" was correlated with acid hydroylsis crystallinity, moisture regain, density, leveling-off degree of polymerization values, and infrared absorbence values for each sample. The results indicate that the index is a time-saving empirical measure of relative crystallinity. The precision of the index in terms of the several crystallinity criteria is given. Based on over 40 samples for which acid hydrolysis crystallinity values were available, the standard error was 6.5 percent.

1736. **CORRESPONDENCE REGARDING "APPLICATION OF INFRARED ABSORPTION SPECTROSCOPY TO INVESTIGATIONS OF COTTON AND MODIFIED COTTONS, PART I"—REPLY TO NORWICH LETTER.** O'Connor, R. T.; DuPré, E. F.; and Mitcham, Donald. Textile Research J. *29:* 365. 1959.

This is a clarification of the article "Application of Infrared Absorption Spectroscopy to Investigations of Cotton and Modified Cottons. Part I. Physical and Crystalline Modifications and Oxidation," which appeared in Textile Research J. *28*: 382–92, 1959, particularly with regard to the use of potassium bromide disks as compared to cast disks to study the spectra of fibers.

1644. **APPLICATIONS OF INFRARED ABSORPTION SPECTROSCOPY TO INVESTIGATIONS OF COTTON AND MODIFIED COTTONS. PART II. CHEMICAL MODIFICATIONS.** O'Connor, R. T.; DuPré, E. F.; and McCall, E. R. Textile Research J. *28:* 542–54. 1958.

The potassium bromide disk technique is being used for rapid, simple, and reproducible measurement of the infrared spectra of modified cotton fibers, yarns, and fabrics. Applications of the procedure have demonstrated that chemical modification can be readily detected and identified and that the extent of treatment can be quantitatively estimated. Experiments have been designed to select bands most useful in investigations of cotton modified by esterification, etherification, or replacement reactions. The examples cited illustrate the potential usefulness of infrared absorption spectra to studies in this field. A list has been prepared of 50 infrared absorption bands (and correlations with vibrating groups that give rise to them) that summarize the spectral characteristics that have been found most useful in investigations of cottons modified by esterification, etherification, and replacement reactions.

1560. **APPLICATIONS OF INFRARED ABSORPTION SPECTROSCOPY TO INVESTIGATION OF COTTON AND MODIFIED COTTONS. I. PHYSICAL AND CRYSTALLINE MODIFICATIONS AND OXIDATION.** O'Connor, R. T.; DuPré, E. F.; and Mitcham, Donald. Textile Research J. *28:* 382–92. 1958.

The recently described potassium bromide procedure for obtaining infrared spectra of cotton cellulose has been applied to an investigation of physical and crystalline modifications and to changes resulting from oxidation. Several experiments to illustrate potential applications are described. Applications to investigations previously suggested in the technical literature are reviewed. It has been demonstrated that infrared absorption spectra of cotton cellulose can be used to follow changes in hydrogen bonding by the classical method of observing the exact wavelengths of the O–H stretching vibrations. Degree of crystallinity can be measured quantitatively as "crystallinity index,' obtained from ratios of intensities of preselected absorption bands. Oxidation changes can be followed only where such processes result in the formation of C-O groups *per se* in the oxidized cotton.

1589. **SOME RELATIONSHIPS BETWEEN SUPERMOLECULAR STRUCTURE AND MECHANICAL BEHAVIOR OF NATIVE AND CHEMICALLY MODIFIED COTTON CELLULOSE.** Tripp, V. W.; Orr, R. S.; Ziifle, H. M.; and Conrad, C. M. Textile Research J. *28:* 404–17. 1958.

Cotton fibers are constructed principally of macromolecules of cellulose that are disposed in the fiber in such a way as to display a number of aspects, which collectively may be referred to as the "supermolecular structure." This structure includes such features as molecular chain length, polymolecularity, natural crosslinkage, crystallinity, crystal modification, crystallite size, orientation, accessibility, and chemical modification. Superimposed on these structural aspects is the gross morphology of the fiber itself. Many of these aspects influence in one way or another the response that the fiber makes when subjected to a variety of mechanical forces, which collectively may be referred to as "mechanical behavior." Among the responses considered are: Strength, elongation, stiffness, toughness, elasticity, and resilience. Selected examples, which show how the mechanical behavior is conditioned in various ways by the supermolecular structure, are presented.

1570. **THE ELECTRON MICROSCOPE IN THE STUDY OF COTTON.** Rollins, M. L.; Moore, A. T.; and Tripp, V. W. Norelco Reptr. *5:* 25–27. 1958.

The application of electron microscopy to cotton has resulted in significant extension and revision of previous findings with the light microscope. The nature of the structural components of the cotton fiber has been observed by surface replication, ultrathin sectioning, fragmentation, and other techniques. The changes brought about in the fiber by physical and chemical modification and by exposure to various environments can be demonstrated graphically by such techniques.

1564. **DECRYSTALLIZATION OF COTTON CELLULOSE.** Haydel, C. H.; Seal, J. F.; Janssen, H. J.; and Vix, H. L. E. Ind. Eng. Chem *50:* 74–75. 1958.

Decrystallized cotton is an experimental product having an elongation at rupture nearly twice that of native cotton, and having other interesting properties. In small-scale experiments, liquid monoethylamine has been used to reduce crystallinity and crystallite length of cotton cellulose, but problems have been encountered in removal of the reagent. It was found that the monoethylamine can be effectively removed by evaporation in nitrogen, and that the type of residual crystal lattice in the product can be controlled by variations in the evaporation procedure. Such procedures reduce fractionation requirements and are cheaper and less toxic than solvents commonly used.

1496. **IMPROVED PROCESS FOR COTTON DECRYSTALLIZATION.** Janssen, H. J.; Haydel, C. H.; Seal, J. F.; and Vix, H. L. E. Textile Research J. *27:* 622–25. 1957.

Ice-cold water was employed to extract residual monoethylamine reagent from decrystallized cotton materials. The use of cold water retained the high degree of decrystallization achieved and further detained the cellulose I crystal lattice of native cotton in the remaining crystalline regions. Advantages of this cold-water extraction process compared with the use of organic solvents are enumerated. Tests were conducted on both laboratory and pilot-plant scales.

1435. **THE SURFACE OF COTTON FIBERS. PART II: MODIFIED FIBERS.** Tripp, V. W.; Moore, A. T.; and Rollins, M. L. Textile Research J. *27:* 427–36. 1957.

Microscopical studies of surface replicas of chemically finished or modified cotton fibers have shown that the characteristic surface of native cotton is often altered by various commercial and experimental treatments. While removing the wax from the fiber surface has little effect, scouring usually uncovers the fine cellulose fibrils of the primary or even the secondary walls. Mercerization does not eliminate the rugosities of the native fiber surface. Additive finishes, including starch, carboxymethyl cellulose, colloidal silica, and acrylic polymer resins, change the original fiber topography in proportion to the amount applied. Chemical modifications that increase the fiber cross-sectional area make the fiber surface smoother, but extensive swelling of the cellulose derivative during its preparation appears to create roughness in some modifications. Crease-resistant finishes do not significantly alter the fiber topography.

1434. **THE SURFACE OF COTTON FIBERS. PART I: NATIVE FIBERS.** Tripp, V. W.; Moore, A. T.; and Rollins, M. L. Textile Research J. *27:* 419–26. 1957.

The topography of unmodified cotton fibers has been examined microscopically by means of surface replica techniques. The outstanding characteristic of the surface is a system of roughly parallel ridges and grooves spiraling around the fiber at an acute angle to its axis; the pattern is a reflection of the spiral fibrillar structure of the cellulose beneath the primary wall of the fiber. The average height and distance between ridges is approximately 0.5 micron, and many of the ridges are 10 or more microns in length. The surfaces of most native cottons are similar, although statistically significant differences in the average distance between ridges were found between certain samples. The surface of fibers from unopened bolls is relatively smooth but assumes the roughness of the typical fiber when dried for the first time.

1491. **CHARACTERIZATION OF CELLULOSE DERIVATIVES BY MEANS OF THE X-RAY DIFFRACTOMETER.** Segal, Leon; and Conrad, C. M. Am. Dyestuff Reptr. *46:* 637–42. 1957.

In studies on the improvement of the properties of cotton fiber, the X-ray diffractometer has been used both qualitatively and quantitatively in evaluating the effects on the fine structure of the fiber of various chemical and mechanical treatments. Information and examples are presented to illustrate the application of the diffractometer to such operations as measurement of crystallite orientation, qualitative detection of the transformation of cellulose from one crystal type to another, measurement of the extent of crystal transformation or chemical cellulose complexes, and determination of changes in degree of crystallinity of the cellulose in the fiber.

1352. **ELECTRON MICROSCOPE—A NEW TOOL FOR TEXTILE RESEARCH.** deGruy, I. V. Textile World *106* (9): 104, 294, 296, 298. 1956.

Principles, operation, and advantages of the electron microscope are discussed briefly. It is being used at the Southern Regional Research Laboratory for research on the morphology of the cotton fiber, to learn the effects of finishing treatments with particular reference to the structure of the primary wall, or outer cover, of the fiber. This work has led to a study of the relation of fiber surfaces to soil retention. Other research problems include studies on the changes in external appearance of the fiber after various industrial treatments of cotton and changes in the internal structure produced by chemical modifications and heat degradation.

1353. **FEATURES OF CELLULOSE FIBER STRUCTURE SHOWN BY DIFFERENTIAL DYEING.** Goldthwait, C. F.; and Sloan, W. G. Am. Dyestuff Reptr. *45:* 813–19. 1956.

Characteristic differences in color have been observed when different cottons, especially cotton fibers of different degrees of development, have been dyed under specified conditions with a mixture of two particular, contrasting, direct dyes, a green and a red. Similarly, very different colors were obtained with different rayons when they were dyed together with the same dye combination. The pronounced differences in color are now explained in accordance with present-day views of the mechanism of direct dyeing and with some of the features of the submicroscopic structures of cellulose fibers. The color differences are due largely to the difference in size and shape between the green and red dyeing units and to differences in accessibility, i.e., in the "channels" for diffusion into and out of the cellulose. Conversely, similar dyeings of unfamiliar cellulose fibers, such as treated cottons and new rayons, allow features of their submicroscopic structure to be recognized, so that conclusions drawn from the colors obtained in the dyeings will aid in characterizing the fibers.

1345. **DETERMINATION OF THE DEGREE OF CRYSTALLITE ORIENTATION IN COTTON FIBERS BY MEANS OF THE RECORDING X-RAY DIFFRACTION SPECTROMETER.** Creely, J. J.; Segal, Leon; and Ziifle, H. M. Textile Research J. *26:* 789–95. 1956.

An improved technique is described for determining quantitatively the degree of crystallite orientation of cellulose in cotton and related cellulosic fibers, by means of the X-ray diffraction spectrometer with potentiometer recording and a rotating specimen mount. The method is based on the angular dispersion of the 002 diffraction arc of cellulose but employs the somewhat more conveniently determined angle at half-maximum intensity instead of the photographically determined "40-percent angle" used by Berkley. It is shown that the angle of half-maximum intensity (50-percent angle by analogy) is less than Berkley's "40-percent angle" by a constant value of 3.3°. Under the condition proposed, the precision of the half-maximum angle is about 0.65°. This compares with a precision of about 1.0° for results obtained by photographic recording and photometering of the X-ray patterns. With the improved X-ray spectrometer technique described, the darkroom required for photographic determination of orientation, including its rigid processing control, can be eliminated; and a determination can be made in about one-fourth of the time.

1128. **EFFECT OF KIERING ON THE CRYSTALLINITY OF COTTON CELLULOSE.** Nelson, M. L.; Segal, Leon; and Ziifle, H. M. Textile Research J. *25:* 534–40. 1955.

Although kier boiling is a common commercial treatment applied to cotton, its effect on the crystallinity of cotton cellulose apparently has not been investigated. In this work, the effect on the crystalline-amorphous ratio of a laboratory kiering and of alcohol extraction and boiling in water under pressure has been studied. Acid-hydrolysis crystallinity determination and moisture-sorption measurements on three varieties of cotton have indicated (1) that standard purification treatments can increase the crystallinity of raw cotton; (2) that the extent of crystallization varies with the individual sample; and (3) that the crystallinity values reported in the literature for purified cottons are probably higher than are those for native cottons because of the changes induced by the purification treatments.

1136. **TREATMENT OF COTTON CELLULOSE WITH AQUEOUS SOLUTIONS OF ETHYLAMINE.** Loeb, Leopold; and Segal, Leon. Textile Research J. *25:* 516–19. 1955.

Aqueous solutions of ethylamine from 70 to 100 percent have been studied to determine their effectiveness in reducing the crystallinity of cotton with high cyanoethyl substitution. The density of cyanoethylated cotton is linearly related to nitrogen content, and the spread of values gives an estimate of uniformity of treatment. Cyanoethylated cotton can be dyed by methods developed for polyacrylonitrile fibers such as those employing acid dyes in the presence of cuprous ion, and the dyed samples so produced are suitable for cross sectioning for microscopic examination. The intensity of dye color can be used as a measure of the amount of cyanoethylation.

1062. **A MICROSCOPICAL STUDY OF THE EFFECTS OF SOME TYPICAL CHEMICAL ENVIRONMENTS ON THE PRIMARY WALL OF COTTON FIBER.** Tripp, V. W.; Moore, A. T.; and Rollins, M. L. Textile Research J. *24:* 956–70. 1954.

The topography and structure of the primary wall of cotton lint fiber are described and illustrated by electron micrographs. Changes brought about by alkali boil (kiering), hypochlorite and peroxide bleaching, mercerization, acid hydrolysis, and dry heat are shown. Noncellulosic constituents are progressively removed during alkaline kiering. Excessive conditions of kiering appear to damage the cellulose framework of the wall. Peroxide bleaching apparently removes noncellulosic material, but hypochlorite alone does not. Mercerization of the isolated wall induces shrinkage, which increases when noncellulosic materials are removed before mercerization. The morphology and structure of the wall account for the observed behavior on mercerization, and electron micrographs of the mercerized wall show a shrunken network of cellulose fibrils. The primary wall resists disintegration by acid hydrolysis; its fibrillar pattern is intact after long periods of contact with hot mineral acid. Long periods of heating in air "set" the primary wall in a configuration similar to that which it had on the corrugated surface of the cotton fiber. The contribution of the primary wall to certain gross properties of the fiber and to its behavior during finishing treatments is discussed.

1063. **CONCENTRIC CELLULOSE LAYERS IN COTTON FIBER CELL WALL.** Tripp, V. W.; and Giuffria, Ruth. Textile Research J. *24:* 757–58. 1954.

In connection with studies of cellulose structure in untreated and modified cotton, electron microscopical observations have been made on ultrathin cross sections of fibers. Concentric cellulosic layers in the secondary wall of untreated cotton fibers were seen only with difficulty, if at all. Partially acetylated fibers swell when embedded by polymerization in a mixture of methyl and butyl methacrylates; and when the embedding medium is cautiously dissolved from the ultrathin sections of these fibers, concentric structures made up of cellulose fibrils are readily apparent. The fibrils composing the structures show strong lateral cohesion, and some 20 to 30 strata of the fibrils are present along any radius of the cell wall. The phenomenon may be useful for cell-wall studies.

986. **OPTICAL AND ELECTRON MICROSCOPIC STUDIES OF COTTON FIBER STRUCTURE.** Rollins, M. L.; and Tripp, V. W. Textile Research J. *24:* 345–57. 1954.

Photomicrographs and electron micrographs illustrate both gross and fine features of the cell-wall morphology. Methods for isolation of components of the cell wall have permitted observations with the light as well as the electron microscope. The first layer of secondary thickening, called the "winding layer," has been isolated from 17-day-old cotton fibers and photographed with both microscopes.

1060. **THE EFFECT OF AQUEOUS HYDROCHLORIC ACID ON THE COTTON CELLULOSE III LATTICE AND ITS IMPLICATIONS CONCERNING THE DETERMINATIONS OF CRYSTALLINITY AND LEVELING-OFF DEGREE OF POLYMERIZATION.** Segal, Leon; and Nelson, M. L. J. Am. Chem. Soc. *76:* 4626–30. 1954.

Cotton cellulose III, prepared by treating cotton in anhydrous ethylamine and decomposing the resulting amine-cellulose complex by removing the amine by evaporation, was treated with hydrochloric acid of various concentrations at high and at low temperatures. X-ray diffraction patterns of the resulting hydrocelluloses showed that reversion of cotton cellulose III to cellulose I, which takes place readily in boiling water, is almost completely prevented by heating in acid when the concentration is 6 *N*, and takes place only to a slight and essentially equal extent in hot 4- and 2-*N* acid; but that very dilute acid (0.1 *N*) does not prevent reversion. The mechanism whereby strong hydrochloric acid prevents reversion of cotton cellulose III to cellulose I is unknown at present.

1059. **ON THE PREPARATION OF CELLULOSE III WITH ETHLYAMINE.** Segal, Leon. Textile Research J. *24:* 861–62. 1954.

The assumption by other investigators that evaporation of ethylamine from amine-saturated cotton cellulose (a treatment developed here to reduce the crystallinity) does not change the type of lattice but only reduces the crystallinity, is refuted. Some ideas are advanced for explaining the results obtained by the other workers.

1054. **PREPARATION OF COTTON CELLULOSE IV FROM COTTON CELLULOSE III.** Loeb, Leopold; and Segal, Leon. J. Polymer Sci. *14:* 121–23. 1954.

Cellulose III was prepared from kiered cotton cellulose (cellulose I) by treatment with ethylamine; the resulting complex breaks down on evaporation of the amine. For conversion to cellulose IV, cellulose III was given a high-temperature glycerin treatment. X-ray fiber patterns of the starting material, cellulose III, and of the material after conversion to cellulose IV, were obtained. The morphological structure of cellulose IV was considerably degraded by the glycerin treatment; the product possessed little tensile strength. Almost no change in the lattice structure was indicated after acid hydrolysis.

987. **SOME ASPECTS OF MICROSCOPY IN CELLULOSE RESEARCH.** Rollins, M. L. Anal. Chem. *26:* 718–24. 1954.

Light microscopy has been an accessory tool to electron microscopy in studies of cotton cellulose. The need to prepare extremely thin sections of cotton fiber for electron microscopy led to development of methods for isolation of individual components of cell wall. Polarized light has been used to gain information on refractive index, degree of birefringence, and angle of crystallite orientation. Other microscopical techniques described include ultraviolet, infrared, and phase microscopy. Results with cotton fibers by use of both electron and light microscopes are given. Quantitative measurements of shrinkage in cotton's primary wall (isolated by special technique) confirm its restrictive influence on fiber swelling. There is evidence that the location and orientation of the cellulosic "winding layer" account for its nonreactivity in certain substitution treatments.

1061. **X-RAYS AID COTTON RESEARCH.** Segal, Leon; and Conrad, C. M. Textile Ind. *111* (12): 116–20. 1954.

The application of X-ray diffraction techniques to cotton cellulose is discussed from the standpoint of cellulose fine structure, types of cellulose crystal lattices, amount of crystalline cellulose, orientation of crystalline cellulose, and crystal size. Examples are given where X-ray techniques have been of great help in plant breeding and in laboratory research on cotton fiber. (Seven figures are included to illustrate text.)

988. **AN X-RAY STUDY OF THE DECOMPOSITION PRODUCT OF THE ETHYLAMINE-CELLULOSE COMPLEX.** Segal, Leon; Loeb, Leopold; and Creely, J. J. J. Polymer Sci. *13:* 193–206. 1954.

The decomposition product of the ethylamine-cellulose complex has been obtained by immersion of cotton fiber in liquid ethylamine and evaporation to dryness. X-ray diffraction patterns of the decomposition product indicate that the crystalline modification present is cellulose III. This formation of cellulose III apparently requires that a critical percentage of the cellulose I lattice be first transformed into the ethylamine-cellulose complex. The delayed appearance of the cellulose III pattern is explained by the slow formation of the ethylamine-cellulose complex within the crystallite, which arises from the compact crystal structure of cellulose I. The appearance and retention of the 020 interference were noted and an attempt was made to explain the phenomenon.

858. **STAINS FOR THE PRIMARY WALL OF THE COTTON FIBER.** Moore, A. T. Stain Technol. *28:* 149–54. 1953.

Several methods are described for distinguishing between the primary wall of the cotton fiber, the lumen, and the secondary wall. The primary wall, a membrane less than 0.5 μ thick covering the entire fiber, was stained while it was attached to the fiber and after it had been mechanically stripped from the fiber. Stains include aqueous or alcoholic solutions of ruthenium red, methylene blue chloride, Nile blue sulfate, oil red, Suden black B, iodine, and Simons' stain. Various concentrations of sodium hydroxide, cupriethylenediamine hydroxide, or sulfuric acid were used to enhance color changes and to swell the cellulose. Fibers stained with Simons' stain and then swelled with dilute cupriethylenediamine hydroxide showed the greatest color differences between the primary wall and the lumen.

910. **SURFACE AREAS OF COTTONS AND MODIFIED COTTONS BEFORE AND AFTER SWELLING AS DETERMINED BY NITROGEN SORPTION.** Forziati, F. H.; Brownell, R. M.; and Hunt, C. M. J. Research, Natl. Bur. Standards *50:* 139–45 (Research Paper 2401). 1953.

Surface areas of cottons differing in variety and maturity and those of cottons that had been subjected to various physical and chemical treatments were measured before and after swelling. The specific surfaces of unswollen fibers were less than 1 square meter per gram; those of the swollen fibers ranged from 4 to 148 square meters per gram. Purification and mercerization increased surface available after swelling; methylenation decreased it; ethylamine treatment had no effect. In the early stages of methanolysis, the surface available after swelling decreased; later, it increased. The procedure followed is believed to be useful in evaluating the effects of various treatments on cottons and on other cellulosic fibers.

861. **FURTHER STUDIES ON COTTON CELLULOSE WITH REDUCED CRYSTALLINITY.** Segal, Leon; Nelson, M. L.; and Conrad, C. M. Textile Research J. *23:* 428–35. 1953.

Variables in the application of anhydrous ethylamine to cotton cellulose to reduce crystallinity have been studied. Crystallinity was estimated by the acid-hydrolysis residue method; crystallite length was indicated by the "leveling-off" degree of polymerization. Crystallinity was reduced rapidly and independently of the degree of polymerization. The maximum reduction occurred in material free of tension. Crystallite orientation was essentially unaffected by the treatment. The cellulose II pattern was always found in the cellulose after contact with mercerizing caustic, regardless of the sequence of treatment. A crystallite length of 150 anhydroglucose units seems to be a more stable structure after the treatment than the 225 units usually found in native cotton.

705. **THIS THING CALLED COTTON.** Rollins, M. L. Cotton Gin & Oil Mill Press *53* (9): 14, 16–17, 36–37. 1952.

Microscopical studies that show the complex structure of cotton are described. Nine illustrations—photomicrographs and electron microscope photographs—show gross and fine features of the cell wall structure. The fibrils of the primary wall (isolated from the fiber by beating in water) range from 1/40 to 1/25 micron in diameter and are randomly oriented. The secondary wall cellulose, composed of fibrils of approximately the same dimensions as those of the primary wall, has a closely packed parallel arrangement, which accounts for the tremendous strength of cotton.

624. **MICROSCOPICAL OBSERVATIONS ON THE CONTENTS OF THE COTTON FIBER LUMEN.** Catlett, M. S.; Giuffria, Ruth; Moore, A. T.; and Rollins, M. L. Textile Research J. *21:* 880–86. 1951.

A method is described for isolating the lumen contents of the cotton fiber by digestion of the cellulose in chilled 72 percent sulfuric acid. Microscopical observations on the isolated "lumens" as well as on the lumen in the whole fiber are reported. The isolated lumens appeared tubular in shape, and electron micrographs of thin sheets of the membrane material showed an unoriented, granular structure. The lumen residue isolated by sulfuric acid was completely hydrolyzed in dilute mineral acid. Amino acid determination by paper chromatography disclosed no free amino acids in the lumen material; but in an acid-hydrolyzed sample glutamic and aspartic acids, valine, alanine, and probably serine and arginine were found, in addition to several unidentified amino acids.

543. **EXPERIMENTS ON THE REDUCTION OF THE CRYSTALLINITY OF COTTON CELLULOSE.** Segal, Leon; Nelson, M. L.; and Conrad, C. M. J. Phys. Colloid Chem. *55:* 325–36. 1951.

In an effort to reduce the crystallinity of the cellulose, certain swelling agents were applied to cotton cellulose and removed by nonaqueous liquids. The crystallinity of the resulting products has been estimated by the acid-hydrolysis residue method. Triton B was capable of lowering the crystallinity of cotton fiber progressively over its critical swelling range, but the result was accompanied by severe damage to the structure of the fiber. Treatment of cotton fibers with anhydrous primary alkylamines reduced crystallinity in varying degree, depending on the amine or mixture of amines used and other conditions employed. These amines did not appear to damage the structure of the fiber. The amine homologs above propylamine reduced crystallinity after preliminary treatment with ethylamine. When an amine-treated cotton, from which the amine has been removed by means of a nonaqueous solvent, is dried and then immersed in boiling water for various periods up to 3 hours, the restoration of the original crystallinity is only slight. X-ray diffraction radial traces qualitatively confirm the conclusions drawn on the basis of crystallinity determinations made by the acid-hydrolysis residue method.

688. **EFFECT OF CHANGES IN CRYSTALLINE STRUCTURE ON THE INFRARED ABSORPTION SPECTRUM OF CELLULOSE.** Forziati, F. H.; and Rowen, J. W. J. Research, Natl. Bur. Standards *46:* 38–42 (Research Paper No. 2172). 1951.

The absorption spectra of native, mercerized, and amorphous celluloses are recorded for the region from 2 to 16 microns. The spectra of the type I celluloses showed sharper and more clearly defined absorption bands than did the spectra of the type II celluloses. The most striking differences were found in the 7- to 8- and 9- to 10-micron regions. In the former region of the spectrum of type I celluloses, definite absorption maxima of nearly equal intensity were found at approximately 7.0, 7.3, 7.4, and 7.5 microns. In the spectrum of type II celluloses, the maximum at 7.4 microns was lacking; while the absorption at 7.3 microns was considerably more intense than that at 7.0 and 7.5 microns. Observations in the 7- to 8-micron region of the spectrum of the amorphous cellulose were prevented by the use of a suspending medium that absorbed in that region. In the 9- to 10-micron region, definite absorption maxima were found at approximately 9.0, 9.4, and 9.6 microns with the type I cellulose. When cellulose I was converted into cellulose II or amorphous cellulose, these maxima merged into a single broad band. Conversion of cellulose I into cellulose II or amorphous cellulose also resulted in an increase in the intensity of the absorption at 11.2 microns. Although factors other than decrease in type I crystallinity may contribute to these changes in absorption characteristics, the changes may prove useful in evaluating changes in crystalline structure of cellulose.

544. **HEAT OF CRYSTALLIZATION OF CELLULOSE.** Ward, Kyle, Jr.; and Reeves, R. E. J. Polymer Sci. *6:* 778. 1951.

The calculations of heat of crystallization of cellulose by Calvet and Hermans (J. Polymer Sci. *6:* 33–38. 1951) have been shown to be dependent on the presumption of equal heats of crystallization for cellulose I (linters) and cellulose II (rayon). It is recommended that a third sample of either modification, but with a different degree of crystallization, be used to check this presumption. Suggested materials are cellulose I (cotton decrystallized with ethylamine) or cellulose II (mercerized cotton).

436. **A ROTATING SPECIMEN MOUNT FOR USE WITH X-RAY SPECTROMETER IN MEASURING CRYSTALLITE ORIENTATION OF CELLULOSIC AND OTHER TEXTILE FIBERS.** Segal, Leon; Creely, J. J.; and Conrad, C. M. Rev. Sci. Instr. *21:* 431–35. 1950.

The quantitative evaluation of crystallite orientation in textile fibers by X-ray methods is discussed. It was found that photographic recording and photometering of the resulting films can be replaced by automatic recording on a strip chart with the aid of an X-ray spectrometer with Geiger-Mueller counter. The design and details are given for a specimen holder capable of properly positioning and rotating a bundle of fibers in the X-ray beam so that the 002 or other selected diffraction arc passes before the window of the counter. A tentative procedure is outlined for evaluating, with the aid of this apparatus, the crystallite orientation of a bundle of cellulose fibers. Some typical recordings of the intensity curves of the 002 arcs from ramie, cotton, and high-tenacity rayon are presented.

445. **CRYSTALLINITY OF CELLULOSE AND ITS SIGNIFICANCE FOR THE FIBER PROPERTIES.** Ward, Kyle, Jr. Textile Research J. *20:* 363–72. 1950.

The concept of crystallinity is discussed in the broad sense, which involves the whole fine structure of cellulose. In this sense, there are four main factors, each involving a mean value and a distribution of values, both mathematical and spatial. These parameters are: (1) The nature of the crystal lattice; (2) the percentage of crystalline material; (3) the size of the crystallites; and (4) the orientation of the crystallites. It is possible, however, to show the marked influence of some of these parameters on certain of the important physical properties of cotton. The relation of physical properties to the crystalline modification has been pointed out frequently by a comparison of the properties of the native fibers with those of regenerated fibers or of mercerized fibers. However, the changes in the percentage of crystalline material that usually occur in these transformations have not been evaluated exactly, and the conclusions drawn from previous studies should probably be checked. Decreased crystallinity and higher content of amorphous cellulose are associated with increased elongation, increased moisture regain, and increased chemical reactivity. Data on the third parameter, the size of the crystallite, are too scanty to permit any conclusions to be drawn. A study of this factor will have to wait on improved methods for measuring the size and size-distribution of the crystalline areas. The increase of fiber strength and of refractive index with improved orientation has been well established. A decrease in elongation usually accompanies this increase.

308. **EFFECT OF GRINDING ON THE CRYSTALLINITY OF CELLULOSE FIBERS, AS INDICATED BY THE ACID-HYDROLYSIS AND OTHER TECHNIQUES.** Nelson, M. L.; and Conrad, C. M. Textile Research J. *18:* 155–65. 1948.

Samples of purified cotton linters and cut cotton were reduced to small particles by increasingly severe grinding. Analysis of the resulting material indicated that particles became definitely smaller as the severity of the grinding increased. Even mild grinding, through a 2-mm. opening, for instance, affected the degree of crystallinity. The reduced crystallinity was accompanied by only a slight change in degree of polymerization in cases of the most severe grinding. Part of the crystallinity lost in grinding was regained when the samples were moistened and then allowed to dry. Measurements of accessibility, heat of wetting, moisture, adsorption, and fluidity for the most part supported the interpretation that grinding caused an increase in the amorphous fraction at the expense of the crystalline fraction of cellulose.

298. **IMPROVEMENTS IN THE ACID-HYDROLYSIS METHOD OF DETERMINING THE CRYSTALLINITY OF CELLULOSE.** Nelson, M. L.; and Conrad, C. M. Textile Research J. *18:* 149–54. 1948.

Problems complicating experimental application of the acid-hydrolysis technique were investigated. Deposition on the hydrolysis residues of small amounts of insoluble humic substances considerably increased mathematical calculations necessary to determine the degree of crystallinity. Therefore, development of a technique for chemically removing these humic substances was undertaken. Solution in 50-percent aqueous monoethanolamine proved satisfactory in the experiments. Additional experiments were directed at finding a satisfactory preliminary purification treatment for cellulose that would not change the crystallinity value. Two-hour extraction with either boiling 1-percent sodium hydroxide or boiling monoethanolamine appeared to give the desired results. On the basis of these studies, a revised procedure for crystallinity determinations is suggested.

244. **PHOTOMICROGRAPHIC COMPARISON OF MILKWEED BAST AND COTTON LINT IN RELATION TO CELL-WALL STRUCTURES OF OTHER NATURAL CELLULOSE FIBERS.** Rollins, Mary L. Botan. Gaz. *108:* 495–510. 1947.

The similarity between two widely different types of fibers such as a seed hair (cotton) and a pericyclic fiber from the stem (milkweed bast) is used to illustrate a basic principle of nature in the structural design of cell walls of the fibrous type. Photomicrographs of fibers swelled in cuprammonium hydroxide are evidence that the cell wall consists of (1) an outer sheath, which is hardly capable of swelling; (2) a many-layered cellulose wall, which may be swelled 10 to 20 times its original size before solvation; and (3) an inner canal enclosed by a lumen wall, which in its reactions is more like the outer membrane of the fiber than it is like the secondary-wall layers. The outer sheath of the fiber appears to be composed of wide, spiral bands; and the cell-wall lamellae appear to be discrete membranes separable by swelling.

274. **CRYSTALLINITY OF CELLULOSE FIBERS AS DETERMINED BY ACID HYDROLYSIS.** Philipp, H. J.; Nelson, M. L.; and Ziifle, H. M. Textile Research J. *17:* 585–96. 1947.

A study of the kinetics of the heterogeneous hydrolysis of cellulose indicates that there are two distinct rates that have been attributed to the rapid hydrolysis of the loose amorphous regions and to the slow hydrolysis of the dense crystalline portions of the fiber. Based on this interpretation, a simple method for determining the relative proportions of crystalline and amorphous cellulose has been developed. Results obtained on four samples of rayon are very well correlated with crystallinity data derived from X-ray diffraction patterns. There is apparently no correlation between the degree of crystallinity and the tenacity of five samples of rayon. In six samples of Stoneville cotton, there appeared to be no relationship between the degree of crystallinity and crystallite orientation. There are indications that the ultimate elongation and the moisture absorption of the rayon samples are proportional to the content of amorphous cellulose.

214. **THE POSSIBLE CONTRIBUTION OF SHAPE TO THE SWELLING AND MOISTURE-SORPTION BEHAVIOR OF COTTON FIBER AT THE SATURATION POINT.** Skau, E. L. Textile Research J. *16:* 556–63. 1946.

On the basis of certain assumptions, a theoretical analysis is made of the possible effect of shape of the cross section of the cotton fiber on moisture regain and swelling at the saturation point. Among the conclusions that may be drawn, with shape considered as the only variable, are the following: Flat fibers would be more efficient than round fibers in making self-sealing fabrics because they have a greater percentage of swelling, a higher degree of "deformability" when fully swollen, and a higher rate of sorption. Flat fibers should be better for absorbent cottons or for fabrics that are to be impregnated. Moisture regain and self-sealing qualities or uptake of an aqueous impregnating or finishing solution are less affected by hardness of twist, tightness of weave, or tension when the yarn or fabric is made of flat fibers. Additional conclusions are implied as to the effect of shape on shrinking, finishing, and dyeing.

123. **APPLICATIONS OF NITROGEN DIOXIDE TREATMENT TO THE MICROSCOPY OF FIBER CELL-WALL STRUCTURE.** Rollins, M. L. Textile Research J. *15:* 65–77. 1945.

Nitrogen dioxide pretreatment is reported as a new technique for the microscopical study of fiber structure by swelling. Fibers treated with nitrogen dioxide were observed microscopically during swelling with lyotropic reagents to study cell-wall structure. Photomicrographs were made at various stages in the swelling process. Certain observations seemed to be at variance with those reported for unoxidized fibers. The differences may have been due to the treatment or to the fact that the samples observed were mature fibers, whereas most reported fiber studies have been on fresh or living cotton fibers at various early stages of maturity.

111. **SOME APPLICATIONS OF MICROSCOPY TO COTTON RESEARCH.** Bailey, T. L. W., Jr.; and Rollins, M. L. Textile Research J. *15:* 1–6. 1945. A paraphrase appears in Textile Mfg. *71:* 205. 1945.

The use of the microscope and the cross-sectioning method in the study of cotton fibers, yarns, and fabrics is discussed. Illustrative photomicrographs of the applications of microscopy to the investigations of chemical and physical treatments of cotton in the field of utilization are given. These studies illustrate the practical application of microscopical methods in problems of both laboratory and pilot-plant investigations.

25. **STRUCTURE OF CELLULOSE AS REVEALED BY OPTICAL AND X-RAY METHODS.** Lyons, J. W. Sci. Monthly *54:* 238–46. 1942.

The early theory that cellulose is amorphous in structure has been disproved and its crystalline structure has been established through microscopic and X-ray studies. By use of the microscope, alternately spiralling fibrils were observed, and the theory that the fibrils are composed of rodlike crystals was proved. It was also learned that the fiber wall is porous. Further information about the size, form, and behavior of crystals has been revealed by X-ray studies. Optical and X-ray studies, methods, and contributions to knowledge of cellulose structure are reviewed in the paper.

Properties

1786. **THE INFLUENCE OF HIGH-ENERGY RADIATION ON COTTON—PART III. 2-THIOBARBITURIC ACID TEST FOR DEGRADATION.** Huo-Ping Pan; Proctor, B. E.; and Goldblith, S. A. Textile Research J. *29:* 425–30. 1959.

Raw cotton irradiated with cathode rays was found to form color compounds with 2-thiobarbituric acid (TBA) in acidic solutions. The color intensity of the test solution was derived from cellulose and the minor constituents of raw cotton. A test method was evolved from this finding based on the measurement of the absorption at 449 mμ. The color of the test solution is stable and the results of the test are reproducible; the test method is direct and rapid to perform. The results of this test compared well with those of the tests of tensile strength, copper number, and intrinsic viscosity. A proposed cotton TBA index is defined. Microbiologically deteriorated cotton is also sensitive to this test. The possibility of using this test for the rapid determination of the quality of raw cotton and other substances that contain cellulose as the major constituent is suggested.

1785. **THE INFLUENCE OF HIGH-ENERGY RADIATION OF COTTON—PART II. EFFECTS ON CHEMICAL MODIFICATION.** Huo-Ping Pan; Proctor, B. E.; Goldblith, S. A.; Morgan, H. M.; and Naar, R. Z. Textile Research J. *29:* 422–25. 1959.

Mercerized cotton yarn and partially acetylated cotton yarn were irradiated with cathode rays. Mercerized yarn and partially acetylated yarns were also prepared from cathode ray-irradiated cotton yarn. The copper number, the intrinsic viscosity, and the tensile strength of these samples were investigated. The results and the behavior patterns of these values were similar to those of the raw cotton yarn from which the chemically modified samples were prepared. The copper number increases with the dose levels of irradiation; the values of intrinsic viscosity decrease with the dose levels. The tensile strength increases slightly with dose levels up to 0.1 megarep and then decreases rapidly. A marked increase was noted in the tensile strength of the yarn that was irradiated at 0.1 megarep and then partially acetylated. The acetyl values of the irradiated acetylated samples were practically constant. However, at dose levels of 100 megarep and above, sharp increases in the apparent values were noted. There are indications that acrylonitrile may form a graft copolymer with cotton cellulose under the influence of gamma radiation.

1784. **THE INFLUENCE OF HIGH-ENERGY RADIATION ON COTTON—PART I. THE PROPERTIES OF RAW COTTON SLIVER LAP, YARN AND FABRIC IRRADIATED UNDER VARIOUS CONDITIONS.** Huo-Ping Pan; Proctor, B. E.; Goldblith, S. A.; Morgan, H. M.; and Naar, R. Z. Textile Research J. *29:* 415–21. 1959.

Sliver lap, yarn, and fabric made of the same raw cotton of known composition were irradiated with cathode rays under various conditions. Changes in the chemical and physical properties were investigated. Some yarns also were irradiated with gamma rays. The changes that occurred in these samples were found to be the same as those in samples irradiated with cathode rays. Data for the copper number, the methylene blue number, and the intrinsic viscosity indicated that degradation of the cathode ray-irradiated yarn had taken place. A new absorption maximum was found in infrared spectrograms of the cotton irradiated at high dose levels. Direct-dye affinity of the irradiated fabric was similar to oxycellulose. The tensile strength of the yarn decreased as the amount of the dose it received increased. However, at low levels, the tensile strength was found to increase to a maximum before it started to decrease; a "natural curve" of tensile strength and a "natural curve" of toughness were defined. Microbiological tests showed that both yarn and fabric were sterilized by a dose of 1 megarep. A general increase in mildew resistance was noted in irradiated samples compared with unirradiated samples.

1735. **PHYSICAL PROPERTIES OF MERCERIZED AND DECRYSTALLIZED COTTONS. PART II. EFFECTS OF STRAINS DURING SWELLING, WASHING, AND DRYING.** Orr, R. S.; Burgis, A. W.; Creely, J. J.; Mares, Trinidad; and Grant, J. N. Textile Research J. *29:* 355–63. 1959.

Yarns from samples of Pima S-1 and Hopi Acala varieties were mercerized and decrystallized when strain was controlled to provide unrestricted shrinkage in length, normal length, and 3 percent extension beyond normal length during ethylamine treatment. Comparisons of effects of sodium hydroxide and ethylamine at different strain conditions were made from measurements on the cellulose, tensile properties of fiber bundles and yarns, and elastic behavior of the yarns. Densities of the mercerized are in general below those of the decrystallized if occluded solvents are removed. The lower densities are in accord with the higher moisture regains for mercerized than for decrystallized cottons. Strains had no influence on the crystallinity ratio during decrystallization but prevented complete conversion to cellulose type II in mercerization. The decreases in bundle tenacities with increases in gage length were essentially equal in the decrystallized and untreated cottons but were smaller in the mercerized cottons. Yarn tenacities of the mercerized and untreated cottons increased as the moisture regain was increased, while those of the decrystallized were essentially equal at standard and wet conditions. Elongation-at-break was decreased by strain during treatment and increased with moisture in the sample when tested. The slack mercerized or decrystallized yarns when strained to less than 2 percent of their elongation-at-break have greater recovery and less permanent set than do untreated yarns. At high strains or stresses, the reverse in recovery and permanent set was found. Yarns treated at normal length have no appreciable difference in recovery and permanent set from untreated yarns.

1734. **PHYSICAL PROPERTIES OF MERCERIZED AND DECRYSTALLIZED COTTONS. PART I. EFFECTS OF SWELLING SOLUTIONS ON FIBERS AND YARNS.** Orr, R. S.; Burgis, A. W.; Andrews, F. R.; and Grant, J. N. Textile Research J. *29:* 350–55. 1959.

One set of yarn samples from Pima S–1, Hopi Acala, and Coker 100 Wilt was mercerized without tension, another set decrystallized with ethylamine, and the two compared with each other and with untreated controls. Breaking loads for yarns immersed in solutions when compared to those immersed in water were essentially unchanged by ethylamine but were decreased appreciably by sodium hydroxide. Untreated yarns in water showed decreases in strength with increases in water temperature. Sodium hydroxide caused yarn to shrink in length as much as 35 percent, but ethylamine caused shrinkage of only about 17 percent. Yarn shrinkages were related to increases in cross-sectional areas of fibers and to cell sizes of the two complexes. Fiber lengths after treatments were unchanged by scouring or extraction but were decreased by the sodium hydroxide and the ethylamine. Mercerization at normal length caused a reduction in the percentage decrease in single fiber and bundle tenacities as the gage length was increased. Strength increases during mercerization are attributed to increased uniformity of strength along the fiber length.

1719. **THE EFFECTS OF GAMMA RADIATION ON COTTON. PART III. BASE EXCHANGE PROPERTIES OF IRRADIATED COTTON.** Demint, R. J.; and Arthur, J. C., Jr. Textile Research J. *29:* 276–78. 1959.

It has been demonstrated by use of a radioactive cations that cottons subjected to gamma radiation have base exchange properties. The number of carboxyl groups on the cottons exhibiting these properties increased with increasing radiation dosage. Salt bonds were probably the major linkages involved, since any cation could be replaced with another cation by varying relative concentrations.

1567. **THE EFFECTS OF GAMMA RADIATION ON COTTON. II. PROPOSED MECHANISM OF THE EFFECTS OF HIGH-ENERGY GAMMA RADIATION ON SOME OF THE MOLECULAR PROPERTIES OF PURIFIED COTTON.** Arthur, J. C., Jr. Textile Research J. *28:* 204–6. 1958.

The proposed mechanism of the effects of high-energy gamma radiation on some of the molecular properties of purified cotton followed the relationship:

$$\ln P = k' \ln N_n + K'$$

where P is the molecular property; N_n is the total number of ionizations or total dosage of gamma radiation received in the system; and k' and K' are constants.

1566. **THE EFFECTS OF GAMMA RADIATION ON COTTON. PART I: SOME OF THE PROPERTIES OF PURIFIED COTTON IRRADIATED IN OXYGEN AND NITROGEN ATMOSPHERES.** Blouin, F. A.; and Arthur, J. C., Jr. Textile Research J. *28:* 198–204. 1958.

Two series of samples of purified cotton were irradiated in oxygen and nitrogen atmospheres with gamma rays at six dosage levels ranging from 100,000 to 100,000,000 roentgens. Some of the chemical and physical properties of the irradiated cellulose were determined by means of various widely used techniques of cellulose chemistry. It was found that high-energy gamma irradiation of cotton resulted in carbonyl group formation, carboxyl group formation, and chain cleavage in the approximate ratio of 20: 1: 1; increased solubility in water and in dilute alkali; decreased tensile strength of the fibers; small but unusual changes in moisture regain; relatively unchanged infrared absorption spectra; and the same type of degradation in a nitrogen atmosphere as in an oxygen atmosphere, with oxygen producing only slight enhancement of the reaction.

1580. **PHYSICAL PROPERTIES OF CHEMICALLY MODIFIED COTTONS: PART IV: EFFECTS OF PARTIAL CARBOXYMETHYLATION.** Grant, J. N.; McDonald, A. W.; and Humphreys, G. C. Textile Research J. *28:* 60–66. 1958.

Yarns from six cottons selected for their widely different inherent fiber characteristics were partially carboxymethylated to a degree of substitution averaging about 0.125 while held at their original length. Moisture regain, linear density, breaking load, and elongation-at-break, measured on the fibers, the yarns, or both, were increased by the modification. Fiber cellulose density and length decreased. Samples of the different cotton varieties were found to differ in their response to the treatment with interrelationships existing between the linear density, degree of substitution, and moisture regain. Changes in fiber properties in the caustic treatments of cottons, such as carboxymethylation and mercerization, were found to be similar when the tensional conditions during treatment were essentially equal.

1498. **INFRARED SPECTROPHOTOMETRIC PROCEDURE FOR ANALYSIS OF CELLULOSE AND MODIFIED CELLULOSE.** O'Connor, R. T.; DuPré, E. F.; and McCall, E. R. Anal Chem. *29:* 998–1005. 1957.

The potassium bromide disk technique can be used for rapid, simple, and reproducible measurement of the infrared spectra of cotton fibers, yarns, and fabrics. Applications of the procedure show that chemical modification can be detected, the character of the modification identified, and the extent of treatment quantitatively estimated. Preliminary experiments indicate that considerable information can be obtained of interest to studies of the oxidation of cotton, to determinations of position of modifying substituents within the cellulose molecule, and to investigations of crystallinity and cross linkage.

1504. **PHYSICAL PROPERTIES OF CHEMICALLY MODIFIED COTTONS. PART III. EFFECTS OF MERCERIZATION.** McDonald, A. W.; Orr, R. S.; Humphreys, G. C.; and Grant, J. N. Textile Research J. *27:* 641–48. 1957.

Yarns from six cottons selected for their widely different inherent fiber characteristics were mercerized (1) under sufficient tension to maintain their original length, and (2) while permitted to contract freely. Fibers were removed from the yarns and were subjected to certain physical measurements. Moisture regain, cellulose density, linear density, breaking load, and elongation-at-break were measured on either fibers, yarns, or both. Samples of the different cottons were found to differ in their response to the treatment. Those samples with a low value in a property generally displayed the greatest percentage of change in that property. Large differences in the properties of the fibers and yarns were associated with the condition of mercerization whether at constant length or slack. Mercerization tended to equalize differences between the properties of fibers in a sample as well as between those of different samples.

1493. **THE EFFECT OF CELLULASE ON THE DEGREE OF POLYMERIZATION OF CELLULOSE AND HYDROCELLULOSE.** Reese, E. T.; Segal, Leon; and Tripp, V. W. (In cooperation with Quartermaster Research and Development Center, Natick, Mass.) Textile Research J. *27:* 626–32. 1957.

On acid hydrolysis of cotton, the degree of polymerization (DP) of the insoluble residue falls rapidly to a low level (leveling off DP). Continued hydrolysis results in further losses in weight, but the DP and the micelle dimensions remain unchanged. Immergut and Ranby suggest that individual micelles at the leveling off DP disappear in entirety; i.e., further action of acid yields soluble fragments only. The present investigation was undertaken to compare the action of enzymes on the micelles with that of acids. The study was broadened by the inclusion of hydrocelluloses from cottons treated in various ways, and was further extended to include the parent materials from which the hydrocelluloses were prepared.

1415. **COTTON FIBERS AS MEANS OF TRANSMITTING WATER VAPOR.** Fourt, Lyman; Craig, R. A.; and Rutherford, M. B. Textile Research J. *27:* 362–68. 1957.

The water vapor transmission of fibers can be measured independently of any air space surrounding the fibers by using sections cut from embedments of the fibers in polyacrylic resins. The rate of water vapor transmission, measured as the diffusion constant, is larger for cotton than for rayon, wool, nylon, or dacron. The respective diffusion constants are on the order of 134, 56, 39, 8, and 7 x 10^{-4} cm.^{2}/sec., under the relatively moist conditions of the tests (between 54- and 93-percent relative humidity). While the possible influence of air in the lumen of cotton has not been completely evaluated, there is evidence that such influence has been reduced, if not eliminated. However, this same evidence indicates that the cotton fibers were in part in an altered condition as a result of the embedment. Even so, the results suggest that cotton is a good choice of fiber for high water vapor transmission along the fiber.

1358. **PHYSICAL PROPERTIES OF CHEMICALLY MODIFIED COTTONS. PART II: EFFECTS OF PARTIAL ACETYLATION.** McDonald, A. W.; Humphreys, G. C.; Orr, R. S.; and Grant, J. N. Textile Research J. *26:* 646–52. 1956.

Yarns manufactured from samples of the same six cotton varieties discussed in Part I (following entry) were partially acetylated to an acetyl content of approximately 24 percent while held under tension. Certain physical properties of the component fibers, fiber bundles, and yarns were then measured. The changes in most properties were found to be associated with differences in the cottons and the acetyl contents. The averages for breaking loads and tenacities of the fibers were decreased, while their linear densities and secant moduli were increased. Breaking loads, linear densities, and secant moduli of the yarns were increased. Elongation of the yarns at break was decreased, while tenacity remained essentially unchanged. The changes were greater for some cottons than for others; whether the changes were advantageous or disadvantageous would depend somewhat on the use to which acetylated cotton is to be put.

1357. **PHYSICAL PROPERTIES OF CHEMICALLY MODIFIED COTTONS. PART I: PROPERTIES OF UNTREATED COTTONS.** McDonald, A. W.; Humphreys, G. C.; Kromhout, O. M.; and Grant, J. N. Textile Research J. *26:* 641–46. 1956.

Six varieties of cotton were given certain chemical treatments, and the resulting changes in their fundamental physical properties were measured. This first report of a series describes the purpose of the work, the methods used to measure the properties, and the types of chemical treatments used. It also furnishes photomicrographs of cross sections of the cotton fibers and the values of the physical properties of the untreated cottons, which are the controls for samples receiving the chemical treatments. Data are given for yarns and fibers of these cottons, and comparisons are made between values of corresponding properties.

1262. **CERTAIN PHYSICAL PROPERTIES OF SELECTED SAMPLES OF CHEMICALLY MODIFIED COTTONS.** Grant, J. N. Textile Research J. *26:* 74–80. 1956. (Republished, Textile J. of Australia *31:* 550–56. 1956.)

Measurements are given on certain physical properties of fibers and yarns for cottons that were chemically modified by mercerization, ethylamine decrystallization, aminization, carboxymethylation, acetylation, and cyanoethylation. The changes in physical properties are shown to be affected by the type of modification, the extent of reaction, and the tensional forces on the yarns during treatment. A spread in the percentage of change was found when untreated cottons with their natural noncellulosic constituents were chemically treated under controlled conditions.

1194. **DENSITY OF MODIFIED COTTONS DETERMINED WITH A GRADIENT COLUMN.** Orr, R. S.; Weiss, L. C.; Moore, H. B.; and Grant, J. N. Textile Research J. *25:* 592–600. 1955.

A rapid method for measuring the density of cellulosic materials with a gradient column is described. Accuracy of the method compares favorably with that of slower methods. Densities of several cottons before and after chemical modification by partial acetylation, carboxymethylation, aminization, and mercerization are given. Percentage of acetyl can be expressed as a function of density in a linear empirical equation over a range of 13- to 42-percent acetyl with a precision of ±2 percent. Density measurements of decrystallized, ball-mill ground, and acid-hydrolyzed cottons were in agreement with the generally accepted concept of the crystalline-amorphous cellulose phase composition of these materials. Cottons from which water was removed by solvent exchange was found to have a high density before, and a low density after, air drying.

800. **PHYSICAL PROPERTIES OF CHEMICALLY MODIFIED COTTONS.** Grant, J. N. The Cotton Research Clinic *1952:* 55–57.

The effect of chemical modification on the physical properties of fibers and yarns was studied through tests on six cottons from commercial production, representing a broad range in physical characteristics. Samples of SxP, Acala 1517, Stoneville 2B, Coker 100 Wilt, Deltapine, and Rowden 41B were processed into yarns of 16/2 construction, and 60-yard skeins were acetylated, mercerized, carboxymethylated, decrystallized, and aminized. From measurements of length, breaking load, weight per unit length, and elongation-at-break of yarns and individual fibers taken from the yarns, the tenacity and stress-strain ratio-at-break were calculated. Fiber tenacity by the flat-bundle method also was determined.

1082. **LITERATURE ON THE NATURAL FIBERS.** Worner, R. K., and Skau, D. B. Advances in Chem. Ser. No. 10. Literature Resources for Chemical Process Industries: 172–90. 1954.

The literature on natural fibers is reviewed and an extensive bibliography provided. References are discussed according to subject classification and varieties of fibers; nomenclature; treatises, monographs, and reviews containing general information; and sources of information on specific fibers. Also discussed are abstracting and indexing services; bibliographies, reading lists, and library catalogs; periodical lists; and sources of miscellaneous information.

926. **ULTRASONIC TREATMENT OF LINT COTTON.** Martin, A. E., Jr. Textile Research J. *23:* 727–30. 1953.

Effects of ultrasonic radiation on lint cotton have been investigated, using relatively large samples and moderate energy levels (400, 500, and 800 kc.). No significant physical or chemical property modification was observed. Crystallinity changed slightly. No differences were noted between effects on lint cotton and on associated foreign matter.

857. **MAGNETIC ANISOTROPY OF CELLULOSIC MATERIALS.** Loeb, Leopold; and Welo, L. A. Textile Research J. *23:* 251–57. 1953.

Results of a survey of the magnetic anisotropy of cellulosic materials measured according to the Krishnan "oscillation" method are presented, and a technique based on a pretreatment with cold dilute acid is described for applying this method to fibrous materials. Data showing the effect on the observed anisotropy of variations in this pretreatment are given. The possible usefulness of the measurements in characterizing molecular orientation is discussed. For a given crystalline modification (cellulose I or II), the anisotropy is primarily a function of molecular orientation but varies with orientation in a different manner for the two modifications. The influence of variations in the amount of crystalline material on values is discussed.

786. **NONFREEZING WATER AND NONFREEZING BENZENE CAPACITIES OF COTTONS AND MODIFIED COTTONS.** Magne, F. C.; and Skau, E. L. Textile Research J. *22:* 748–56. 1952.

The calorimetric, heat-of-fusion method has been used to determine the nonfreezing water present in cotton and modified cotton fibers at various moisture contents. On desorption at room temperature, all the water that will freeze at −4.5° C. is removed before the fibers release nonfreezing water. In general, the results indicated that the nonfreezing water capacity was related to the total available surface, the proportion of amorphous cellulose, and the degree of distention of the wetted fibers. The nonfreezing benzene values seem to refute the solvent theory and to corroborate the theory of capillarity for explaining the lowered activity of benzene in cellulose and, by implication, the lowered activity of water in cellulose.

707. **SOME RELATIONS BETWEEN INTRINSIC AND SPECIFIC VISCOSITY IN CELLULOSE SOLUTIONS AT A CONTROLLED VELOCITY GRADIENT.** Tripp, V. W.; Conrad, C. M.; and Mares, Trinidad. J. Phys. Chem. *56:* 693–96. 1952.

Empirical equations relating the specific viscosity determined at a constant velocity gradient and at two convenient concentrations (0.25 and 0.50 g./dl.) with the intrinsic viscosity have been derived for solutions of cellulose in cuprammonium and cupriethylenediamine hydroxides. Use of the relations requires adjustment of viscosity data to a mean velocity gradient of 500 sec.$^{-1}$ whenever the cellulose has an intrinsic viscosity greater than 5 or 6, the difference depending on solvent used.

709. **SWELLING CAPACITIES OF FIBERS IN WATER. PART II. CENTRIFUGE STUDIES.** Welo, L. A.; Ziifle, H. M.; and McDonald, A. W. Textile Research J. *22:* 261–73. 1952.

In the centrifuge technique, the swelling capacity of cotton and other fibers appears as a function of the moisture retention after swelling and centrifuging. The complication of dealing simultaneously with the time and speed of centrifuging was avoided by noting that straight lines (to a high degree of approximation) were obtained when moisture regains were plotted against the squares of rotational speeds. The intercept values were the same and were reproducible for any selected centrifuging time of 20 minutes or more, provided the minimum acceleration was above 3,200 g. The zero-speed intercepts on the moisture regain axis did not represent true swelling capacities. Nevertheless, the technique could be useful for detecting and measuring differences in water-holding capacity brought about by chemical treatment. A quantitative theory of the behavior of the fiber-water system in the centrifuge was developed, based on simple capillary considerations.

708. **SWELLING CAPACITIES OF FIBERS IN WATER. PART I. DESICCATION RATE MEASUREMENTS.** Welo, L. A.; Ziifle, H. M.; and Loeb, Leopold. Textile Research J. *22:* 254–61. 1952.

The swelling capacities of cotton and other fibers have been determined by measuring the rate of loss of moisture from a moisture-saturated sample (rate of desiccation) as follows: Fully swollen samples containing excess water were dried very slowly and weighed periodically. The maximum regain values, when expressed in terms of volume increases, agree with the swelling capacities as determined by microscopic measurements; but the long drying periods required make this method suitable for use in research when time is not an important consideration.

699. **VISCOSITY MEASUREMENTS (THEIR VALUE TO COTTON).** Crow, J. H.; and Conrad, C. M. Textile Ind. *116* (5): 110–11, 121. 1952.

Cupriethylene is used as the solvent in an improved method of measuring the viscosity of cellulose to make the determination more applicable to cotton. This solvent is less volatile than cuprammonium hydroxide, the solvent in the usual methods. Another advantage is that the new test method specifies conditions that make the kind of viscometer to be used unimportant.

626. **MICROSCOPIC STUDIES ON THE SWELLING OF NATIVE, BLEACHED AND NITRATED CELLULOSE FIBERS.** deGruy, I. V.; and Tripp, V. W. Botan. Rev. *17:* 555–628. 1951. (A translation from the French article by G. Mangenot and M. Raison published in *Revue de Cytologie et Cytophysiologie Vegetales,* Vol. 6, Part 1. 1942.)

The swelling patterns of cotton, flax, ramie, and the grasses have been examined microscopically. Swelling was brought about in the unmodified or bleached cellulose with Schweitzer's reagent (cuprammonium hydroxide) or cupriethylenediamine hydroxide and in the nitrated fibers with neutral solvents such as acetone, cyclopentanone, methyl alcohol, and nitroglycerin. Strata that are resistant to swelling dissolution are present in all the fibers examined, even in those that have been scoured and bleached. These strata include, besides the primary wall (cuticle) and middle lamella, an internal sheath immediately surrounding the lumen and structures in the thickness of the secondary wall, generally annular or spiraled. The structure of the fibers is used as a criterion of the theories proposed in the past to account for their swelling behavior and physical and chemical characteristics. Similarities and differences between the fibers studied are pointed out. The review is illustrated by 51 figures and cites 78 references.

617. INTRINSIC VISCOSITIES OF CELLULOSE AS AFFECTED BY RATE OF SHEAR. Conrad, C. M.; Tripp, V. W.; and Mares, Trinidad. J. Phys. Colloid Chem. *55:* 1474–91. 1951.

Martin's equation for determining intrinsic viscosity has been applied to seven celluloses, representing an extreme range of degrees of polymerization. Results of the determinations, made in both cuprammonium and cupriethylenediamine solvents, were read off from curves at the velocity gradients 300, 500, and 200 sec.^{-1} The intrinsic viscosities were also computed from viscometer readings taken without regard to velocity gradient.

529. SIMPLE EXPRESSIONS FOR THE CIRCULARITY AND FULLNESS OF FIBERS. Skau, E. L. Textile Research J. *21:* 14–17. 1951.

The roundness of cotton and other fibers has an important influence on luster, resilience, mercerization, suitability for mercerization, breaking strength, spinning and dyeing qualities, and other properties. A sound method of designating shape by means of a simple function that can be used as a numerical index has been needed. A simple expression, $\frac{4\eta A}{p^2}$, has now been derived mathematically for indicating the degree of circularity of fiber cross sections, A being the area and p the perimeter of the cross section. This index has been useful in investigations of the swelling of cotton in water and of the orifice test for closing capacity of cotton fibers. Similar functions have been derived to express the fullness and the deformability of fibers.

536. THE RELATION OF LENGTH TO OTHER PHYSICAL PROPERTIES OF COTTON FIBERS. Morlier, O. W.; Orr, R. S.; and Grant, J. N. Textile Research J. *21:* 6–13. 1951.

The results of an investigation of the relation of tenacity of single fibers to fiber length are reported, and the instrument used in making the tests is described. Also described is a method for calculating a tenacity "index" for a cotton sample on the basis of single-fiber tests on only three length groups. The average breaking load and the average tenacity of single fibers increased with increasing fiber length within a sample. Within a sample, weight fineness (taken on the center part of the fiber) reached a maximum for fibers, the length of which is near the modal length. With increasing fiber length, elongation-at-break increased; ratio of elongation-at-break to breaking load decreased; and coefficients of variation for both breaking load and elongation decreased. The finer varieties exhibited the greater average stiffness, or ratio of tenacity to strain.

565. DYEING COTTON TO TEST ITS FIBERS. Goldthwait, C. F. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 431–35.

The details are given of a new dyeing test that helps in determining the quality of cotton at all stages—from the growing boll to piece goods ready for dyeing in the finishing plant. The technique distinguishes thin-walled (immature) from thick-walled (mature) cotton fibers. It consists simply of the dyeing of cotton samples in the same dye bath with two direct dyestuffs, a red and a green dye, followed by a special washing treatment. Various applications of the technique in mills to detect the presence of the thin-walled fibers in excessive amounts, and to avoid several types of difficulties that arise in both manufacturing and finishing of cotton, are discussed in detail. Since the differential dyeing effect depends on fundamental differences in cellulose, the test has still broader applications for the study of cotton and other cellulose fibers.

566. FIBERS IN A DIFFERENT LIGHT. deGruy, I. V.; and Rollins, M. L. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 394–99

Methods of comparing the microscopical characteristics of cotton and other fibers to evaluate cotton for specific uses in competition with other fibers are discussed. The internal structure of the cotton fiber as revealed by the microscope is of interest in interpreting the results of chemical treatments to modify the cellulose of the fiber. Staining techniques used to study the location of colorless materials that the chemist has put into a yarn, cross-sectioning techniques, and the many uses of the microscope in cotton research and in related branches of research are discussed.

439. SPECIAL DYEING OF COTTON ON THE SEED GIVES VISUAL EVIDENCE OF CHANGES DURING FIBER DEVELOPMENT. Goldthwait, C. F.; Smith, H. O.; and Roberts, F. T. Textile Research J. *20:* 100–4. 1950.

A process of differential dyeing employed to distinguish between thick- and thin-walled cotton fibers has now been utilized to show visually that the drying of normal cotton fibers for the first time—as when the boll opens in the field—greatly affects their dyeing properties. The effect was observed as a pronounced color difference when one lock from a nearly mature boll cut open in the laboratory was dried and another lock was kept wet; when both were dyed in the same dye bath at the same time, the dried cotton dyed mainly red and the undried dyed green. The change in the cotton cellulose that caused the difference is undoubtedly submicroscopic. It takes place in addition to the changes visible in the microscope that are familiar in fibers that have dried normally on the plant. A significant feature of the submicroscopic change can be inferred from the dyeing behavior considered in relation to current views of the mechanism of direct dyeing—that is, undried fibers from a cotton boll are shown by a new technique to be more porous than fibers that have dried in the boll; and the thin-walled fibers in ordinary cotton are similarly more porous than the thick-walled fibers, at least while wet in a hot dye bath. It follows that the differential-dyeing effect with cotton fibers is determined by cellulose structure in combination with specific properties of the two dyes employed.

483. THE SWELLING OF COTTON IN WATER: A MICROSCOPICAL STUDY. Moore, A. T.; Scott, L. W.; deGruy, I. V.; and Rollins, M. L. Textile Research J. *20:* 620–30. 1950.

A method is described for comparing microscopically the cross-sectional areas of the same cotton fiber in wet and dry conditions for evaluation of swelling. Results indicated a change in cross-sectional area of raw cotton fibers of between 24 and 33 percent of the dry area regardless of variety or degree of maturity. Immature samples showed slightly less mean swelling than did mature samples, but this was believed due to the presence of "dead" fibers. Immature samples showed slightly more deformation—change in circularity—than did mature fibers. This tendency and the fact that there are about twice as many fibers in a given weight of immature as in a like weight of mature fibers, help to explain the greater closing capacity of yarns made from immature cotton. Flax and a sample of viscose rayon showed twice the swelling of cotton, Fortisan two-thirds as much, and nylon no cross-sectional swelling at all.

377. THE ACTION OF LIGHT ON TEXTILE MATERIALS. A REVIEW OF THE LITERATURE. Appleby, D. K. Am. Dyestuff Reptr. *38:* 149–56, 189–92. 1949.

Findings reported by various investigators from 1920 to 1948 on the action of light on cotton, bast fibers, wool, silk, and manufactured fibers are reviewed and compared. A bibliography consisting of 232 references is appended.

268. **NEW DYE TECHNIQUE SHOWS "MATURITY" OF COTTON.** Goldthwait, C. F.; Smith, H. O.; and Barnett, M. P. Textile World *97* (7) : 105–8, 201–2, 204, 206. 1947.

Details are given of a technique that employs direct dyeing with a particular combination of two dyes of contrasting color and of different dyeing properties for detecting the presence of the thin-walled, or immature, cotton fibers that often cause problems during processing. The method has been used to diagnose trouble experienced by a cotton mill in manufacturing and in dyeing. Its simplicity, together with the extreme color contrast frequently obtained, suggests a wide field of usefulness. A number of these possibilities are discussed. Colored photographs illustrate the material.

273. **A CALORIMETRIC INVESTIGATION OF MOISTURE IN TEXTILE FIBERS.** Magne, F. C.; Portas, H. J.; and Wakeham, Helmut. J. Am. Chem. Soc. *69:* 1896–1902. 1947.

The calorimetric technique employing the method of mixtures has been applied in a study of the nature of moisture in textile fibers. Measurements were made on native and mercerized cotton fibers and on rayon, nylon, and glass fibers with various moisture contents. The amounts of freezing and nonfreezing water were calculated for each fiber-moisture combination measured. Interpretation of the results for cellulose fibers permits differentiation between water of primary adsorption and water adsorbed in multilayer formation or by capillary condensation. From the data obtained, estimates of the degree of crystallinity and capillary volumes with certain limiting radii were made for the fibers.

207. **CELLULOSE BEHAVIOR WITH FILTERED LIGHT FROM A CARBON ARC SOURCE.** Campbell, K. S.; and Fynn, P. J. Textile Research J. *16:* 450–58. 1946.

The relative action of various spectral regions or combinations of regions on cotton cellulose was studied with a carbon arc lamp as a source of radiation and six Corning glass filters as a means of obtaining certain selected spectral regions of incident energy. For some exposures tungsten "infrared" lamps were used, with and without certain of the glass filters. The results suggest that certain wavelength regions in the spectrum may interact in such a manner as to reduce the net degrading effect on cotton cellulose of the total incident radiant energy. Thus clear glass, when used to screen a sample of cotton fabric from carbon arc radiation, has a slightly greater protective effect than does blue glass. Observation of the bleaching and yellowing action of radiant energy of various spectral distributions under several conditions showed no direct relation between this effect and degradation.

175. **CONVENIENT ADJUSTMENT TO A STANDARD VELOCITY GRADIENT OF THE FLUIDITY OF ANOMALOUS CUPRAMMONIUM SOLUTIONS OF CELLULOSE.** Conrad, C. M.; and Tripp, V. W. Textile Research J. *61:* 275–83. 1946.

A technique is described whereby, under certain conditions, velocity gradient adjustments can be made with a reasonable degree of accuracy, even though a single-discharge viscometer is employed. This technique was applied for determining the fluidity of "anomalous" cuprammonium solutions of cotton cellulose. An equation was derived that permits calculation of the fluidity at a gradient of 500 reciprocal seconds from a single pair of fluidity and velocity gradient values at any other gradient within the practical range of measurement.

117. **THE INFLUENCE OF VELOCITY GRADIENT ON THE RELATION BETWEEN VISCOSITY AND CONCENTRATION IN CUPRAMMONIUM SOLUTIONS OF CELLULOSE.** Lyons, J. W. Chem. Phys. *13:* 43–52. 1945.

This study calls attention to the fact that the viscosity-concentration relationship for a high-polymer solution such as that of cellulose in cuprammonium hydroxide depends on the velocity gradient at which the viscosity is measured. Consequently, the intrinsic velocity calculated from data obtained on a solution in the anomalous region has a different value for each velocity gradient prevailing during measurement. An empirical modification of the Baker-Philippoff equation gives a uniform value for the intrinsic viscosity of a given solution regardless of changes in velocity gradient.

129. **WATER-TIGHT FABRICS MADE BY SWELLING COTTON FIBERS.** Goldthwait, C. F.; and Smith, H. O. extile World *97* (7): 105, 106, 196, 198. 1945.

A new method for making a water-holding cotton firehose without the use of rubber lining involves the addition to the yarn before weaving of a swellable finishing material, not soluble in water, to supplement the swelling of the cotton and thus produce a self-sealing fabric. A commercial hydroxyl ethyl ether of cellulose was used as the swellable agent. The method appears applicable to any cloth construction intended to utilize the principle of swelling.

56. **THE OPTICAL ROTATION OF CELLULOSE AND GLUCOSIDES IN CUPRAMMONIUM HYDROXIDE SOLUTION.** Reeves, R. E. Science *99:* 148–49. 1944.

The high (levo) optical rotation of cellulose in cuprammonium hydroxide solution is believed to be a property of a complex formed by a copper-containing radical and free hydroxyl groups of cellulose. Experiments reported show that complexes of similarly high rotation are formed when appropriately substituted simple glucosides are dissolved in cuprammonium hydroxide solution. The levo-rotary complex appears to be a cyclic structure involving hydroxyl groups on glucose carbon atoms 2 and 3. The optical rotation in water and cuprammonium hydroxide solution for cellulose and several alpha- and beta-methylglucosides is given, with differences.

17. **CRYSTAL DENSITY OF NATIVE CELLULOSE.** Lyons, W. J. J. Chem. Phys. *9:* 377–78. 1941.

Values employed for the density of cellulose are discussed. It is pointed out that there is excellent agreement between the experimental value of 1.585 g/cc obtained by Stamm and Hansen and the theoretical value calculated from Meyer's revised model of the unit of native cellulose.

CHEMICAL TREATMENT AND MODIFICATION

Wash-Wear

1890. **DEVELOPMENT OF METHODS OF RESIN APPLICATION TO COTTON GARMENTS FOR DURABLE CREASING AND WRINKLE RESISTANCE BY USE OF STANDARD DRYCLEANING EQUIPMENT.** Wiebush, J. R.; Graham, R. T.; and Loibl, Fred. Natl. Inst. Drycleaning Pub. *F–19*, 4 pp. December 1959.

A research program has been carried out under contract by the National Institute of Drycleaning to determine the feasibility of the application of finishes to impart wrinkle resistance and durable creases to cotton garments by use of ordinary drycleaning plant equipment. It has been shown that such finishes can be successfully applied to many types of garments, particularly shirts, blouses, skirts, trousers, and jackets. In general, medium- or light-weight plain-weave fabrics, such as print cloth, ginghams, and broadcloths, respond better than heavier weight fabrics. The finishing procedure consists of applying a resin formulation, extracting in a centrifuge to control the pickup, shaping the garment with hot-head presses and hand equipment, and completing the cure in a hot-air drying cabinet. The garment is then washed and tumbled dry. The effect of variations in this procedure are reported. Preliminary cost data on the process have been calculated. This type of finishing is best suited for use in conjunction with garment manufacturing but could be useful as a supplementary service by many drycleaners, especially during the slack season.

1812. **DURABLE CREASES PRODUCED IN COTTON AND RESIN FINISHED COTTON FABRICS BY AN ALKALI PROCESS.** Reeves, W. A.; and Mack, C. H. Am. Dyestuff Reptr. *48* (21) : 43–46, 50. 1959.

A process is described for imparting durable creases to cotton fabrics. The process utilizes mercerization strength alkali solutions and is applicable to most types of resin-treated and crosslinked fabrics, as well as to unfinished cotton fabrics. Creases are produced by moistening the area to be creased with alkali solution, then ironing in the crease with a hot iron. Creases produced by the process remain sharp after many launderings.

1807. **CHLORINE-RESISTANT BLENDS OF TRIAZONE AND UREA DERIVATIVES FOR WRINKLE-RESISTANT COTTON FABRICS.** Frick, J. G., Jr.; Arceneaux, R. L.; Reinhardt, R. M.; and Reid, J. D. Am. Dyestuff Reptr. *48* (15) : 29–31, 36. 1959.

Wrinkle-resistant finishes prepared from blended methylol derivatives of ethyl triazone and urea are described. Some of these finishes are not subject to damage from retained chlorine and possess economical and other advantages over the triazone finishing agents used alone.

1845. **WRINKLE-RESISTANT COTTON WITH DURABLE CHLORINE RESISTANCE.** Frick, J. G., Jr.; Murphy, P. J., Jr.; Reinhardt, R. M.; Arceneaux, R. L.; and Reid, J. D. Am. Dyestuff Reptr. *48* (18) : 37–40. 1959.

Finishing agents for producing wrinkle-resistant and wash-and-wear cotton fabrics have been developed, using mixtures of dimethylol ethyleneurea and a formal of a polyhydroxy compound. These agents give good wrinkle resistance and chlorine resistance, both of which are durable to repeated launderings.

1819. **IMPARTING WET CREASE RESISTANCE TO COTTON FABRICS BY CROSSLINKING WITH AQUEOUS FORMALDEHYDE.** Guthrie, J. D. Textile Research J. *29:* 834–36. 1959.

The wet-crease recovery of cotton fabrics was improved by crosslinking with aqueous formaldehyde, using acidic catalysts. With formic acid or ammonium chloride, a solution temperature of about 80° C. was required for 6 hours to obtain good wet-crease recovery; but with sulfuric acid, 3 hours at room temperature (28° C.) gave satisfactory results. Dry-crease recovery was not improved significantly. Strength losses appeared to be in the range tolerated for wash-and-wear fabrics.

1833. **PHENOLIC-FORMALDEHYDE RESINS AS FINISHING AGENTS FOR COTTON FABRICS.** Chance, L. H.; Perkerson, F. S.; and McMillan, O. J., Jr. Textile Research J. *29:* 558–64. 1959.

Cotton fabric was treated with phenolic-formaldehyde resins and seven halogenated phenolic-formaldehyde resins and the properties of the various samples were evaluated. The fabric was treated by padding it through a solution of phenol in alkaline aqueous formaldehyde, drying, and curing in an oven. All the fabrics had improved rot resistance and crease recovery. The halogenated phenols did not seem to have any advantage over plain phenol in imparting rot resistance to cotton fabric. Fabrics treated with *m*-chlorophenol and *m*-bromophenol had the highest crease recovery.

1716. **CHEMICAL AND PHYSICAL EFFECTS OF FINISHING COTTON WITH METHYLOL DERIVATIVES OF ETHYLENEUREA.** Frick, J. G., Jr.; Kottes, B. A.; and Reid, J. D. Textile Research J. *29:* 314–22. 1959.

A study has been made of the mechanism by which cotton is made wrinkle resistant by dimethylol ethyleneurea. Estimates are made of the length of crosslinks and the relative effect of several factors, including processing conditions, crosslinkage, and acid damage, on the loss in strength of the fabric caused by treatment. Various methylol derivatives of ethyleneurea were used in the study of the effect on chemical and physical properties. It has been demonstrated that the methylol derivatives of ethyleneurea react chemically with cellulose under the influence of acidic catalysts. Metallic salts are most efficient in promoting this reaction. Both monofunctional and difunctional compounds react with the cellulose. The latter, however, cause crosslinkage, which effects marked changes in the physical properties of the treated cotton fabric, particularly wrinkle resistance. Dimethylol ethyleneurea forms crosslinks averaging 1.4 to 1.5 ethyleneurea residues in length. These residues are connected by methylene groups. The effects of variations in catalyst, composition of the finishing agent, and curing conditions are shown. Relation of the findings to practical finishing is discussed.

1724. **IMPARTING CREASE RESISTANCE AND CREASE RETENTION TO COTTON WITH APO.** Drake, G. L., Jr.; and Guthrie, J. D. Textile Research J. *29:* 155–64. 1959.

Cotton fabric (80 x 80) was made crease resistant by processing with APO, tris(1-aziridinyl)phosphine oxide. Application was made by wetting the fabric with an aqueous solution of APO containing catalytic quantities of zinc fluoborate, squeezing out the excess with squeeze rolls, drying for 4 minutes at 80° to 90° C., and curing for 4 minutes at 140°, followed by a good wash. An aftertreatment with a 1-percent Primenit VS[3] solution increased the crease-recovery angle. Monsanto crease angles of from 250° to more than 300° (warp + fill) have been obtained, depending on the resin add-on. The crease recovery is not changed much by home laundering. A loss of 30 percent in the Elmendorf tearing strength was observed in samples with over 300° crease-recovery angles. Creases durable to washing were obtained by drying the fabric with a hand iron followed by an oven cure. The resin could not be stripped from the fabric by methods that are effective with other resins. In addition to imparting crease resistance, this resin also imparts some degree of flame resistance.

1732. **PERMANENT SET IN COTTON AND THE PHYSICAL MECHANISM OF WRINKLE-RESISTANT TREATMENTS.** DuPré, A. M., Jr. Textile Research J. *29:* 151–55. 1959.

The mechanism of stretching of the cotton fiber is essentially different from that of any other textile fiber, either natural or synthetic. Because there are frequent reversals in the spiraling direction of the fibrils, and because the reversals in all the growth layers, beginning with about the second, occur at approximately the same cross-sectional points along the length of the fiber, the cotton fiber stretches by actually untwisting. More specifically, each segment between two points of reversal untwists, with the segment on one side of a reversal untwisting in a direction opposite to that of the segment on the other side. Hence, it is deduced that a set of torques is set up along the length of the fiber when it is stretched. Further, the average angle of the fibrils to the fiber axis is of a magnitude such that the amount of elongation observed in cotton fibers can be accounted for by this untwisting, without assuming any elongation in the fibrils themselves. Studies made with the electron microscope show that, on extreme swelling, the growth layers are separated, with little evidence of swelling of the fibrils themselves. Also, when cotton fibers are mechanically broken up in water in a Waring blendor, there is evidence of strong lateral cohesion betwèen fibrils. These facts have important implications regarding (1) the nature of permanent set in cotton fibers with respect to cotton's unique structure, and (2) the mechanism by which crosslinking agents reduce the elongation and increase the elastic recovery of cotton fibers. A brief review of some phases of current theories in this field is given, together with some observations pertinent to their validity. It is proposed that there is at least some relative movement between growth layers, that this relative movement may contribute significantly to permanent set, and that crosslinking between growth layers may contribute appreciably to wrinkle resistance.

1738. **TETRAHYDROPYRIMIDINONE DERIVATIVES For NONCHLORINE RETENTIVE, WRINKLE-RESISTANT COTTON FABRICS.** Frick, J. G., Jr.; Kottes, B. A.; and Reid, J. D. Am. Dyestuff Reptr. *48:* 23–25. 1959.

A wrinkle-resistant and wash-wear finish for cotton fabrics based on the dimethylol derivative of tetrahydro-5-hydroxy-2(1H)-pyrimidinone has been developed that shows several advantages over currently used finishes. The finishing agent is structurally similar to dimethylol ethyleneurea and produces a finish with similar properties. It causes no chlorine retention, however, and this property is retained after repeated hot, alkaline launderings. Also, it does not yellow on heating as the triazone finishes often do, and it leaves no residual odor. It is, however, susceptible to hydrolytic removal by acidic conditions below pH 4, which renders it vulnerable to overly acidic or hot, souring conditions. Although in this vulnerability it is similar to finishes produced from dimethylol ethyleneurea, the pyrimidinone finish loses less chlorine resistance than does the ethyleneurea finish under acidic conditions, prior to complete removal.

1725. **IMPARTING WRINKLE RESISTANCE TO COTTON FABRICS WITH TRIAZONE DERIVATIVES.** Reid, J. D.; Frick, J. G., Jr.; Reinhardt, R. M.; and Arceneaux, R. L. Am. Dyestuff Reptr. *48:* 81–90. 1959.

The need for a finishing agent that will give good wrinkle resistance and other improved textile properties to cotton and that will be practically unaffected by laundering, particularly by chlorine bleaching and the highly alkaline and acid conditions encountered in commercial laundering, led to an investigation of some "triazone" derivatives. Since compounds of this type are coming into commercial use in this country and in Europe, an evaluation of the properties is in order. The methylol derivatives of 5-substituted tetrahydrotrizinone have been investigated as finishing agents for imparting wrinkle resistance and "minimum-care" properties to cotton fabrics. The preparation and properties of some of these agents and the properties of the finished fabrics are described. These triazones are potentially inexpensive and may be applied to fabric by conventional procedures. The properties of the finished fabrics are compared with those of fabrics finished with some other commercial wrinkle-resistance agents, and the advantages and disadvantages of each are discussed.

1643. **AFTERMERCERIZATION OF WRINKLE-RESISTANT COTTONS FOR IMPROVED STRENGTH AND ABRASION RESISTANCE.** Reinhardt, R. M.; Kullman, R. M. H.; Moore, H. B.; and Reid, J. D. Am. Dyestuff Reptr. *47:* 758–64. 1958.

A previous study showed that improvement in tearing strength and abrasion resistance was produced by aftermercerization of cotton treated with methylolmelamine. This study has been continued with fabric treated with a number of other finishing agents. Along with the beneficial effects, there is some loss of wrinkle-recovery angle. This loss can be kept to a minimum with properly selected conditions for mercerization of the treated fabric. The gain in strength and abrasion resistance appears to outweigh the loss in wrinkle resistance. Well-cured samples can be mercerized to effect the improvements and still have acceptable wrinkle-recovery angles. Wrinkle-resistant cottons investigated were fabrics treated with both nitrogenous and nonnitrogenous finish agents. The former group included dimethylol cyclic ethyleneurea, methylated methylolmelamine, and a methylolated triazone derivative. Formaldehyde, glutaraldehyde, pentaerythritol acetal, and an epoxy finishing agent were among those of the nonnitrogenous group. Variables in the conditions of mercerization and the results obtained are discussed. The effect of fabric construction on changes in tearing strength caused by mercerization of cloth treated with dimethylol cyclic ethyleneurea is also considered.

1650. **EFFECT OF COMMERCIAL LAUNDERING ON CEU-TREATED COTTON FABRICS.** Mazzeno, L. W., Jr.; Kullman, R. M. H.; Reinhardt, R. M.; and Reid, J. D. Am. Dyestuff Reptr. *47:* 609–13. 1958.

An untreated control, cloth treated with cyclic ethylene urea (CEU), and cloth treated with a CEU-acrylate-silicone finish were subjected to commercial laundering at four locations to determine the effect of this type of laundering on resin-treated cotton fabrics. Soiling of the sample treated with the CEU-acrylate-silicone resin was observed as a result of laundering with dirty clothing and appeared to be due to a tendency of the thermoplastic additives of this finish to attract and scavenge dirt from the laundry water. Apparently, the chlorine bleach used by these laundries did not harm the finish. The durability of the physical properties—breaking strength, tearing strength, flex abrasion, wrinkle recovery, and nitrogen content—was very good to laundering in which the souring step was well controlled. With oversouring, resin was removed by hydrolysis. This resulted in decreased wrinkle recovery and an increase in most of the other properties. Investigation of the conditions of souring indicated the rate of hydrolysis to be greatly increased by elevated temperatures and by pH below 4.

1593. **WET-SOILING STUDIES ON RESIN-TREATED COTTON FABRICS.** Mazzeno, L. W., Jr.; Kullman, R. M. H.; Reinhardt, R. M.; Moore, H. B.; and Reid, J. D. Am. Dyestuff Reptr. *47:* 299–302. 1958.

Cotton cloth treated with a cyclic ethylene urea-acrylate-silicone finish has been found to be subject to wet soiling, especially under conditions such as are encountered in commercial laundering. Once soiled, the CEU-acrylate-silicone finished cotton cannot be cleaned—the soiling is irreversible. Carboxymethyl cellulose will decrease the amount of soiling slightly but not sufficiently for good reconditioning. Drycleaning is likewise ineffective. The chief causes of the soiling are the soft, tacky films of acrylate and silicone that are deposited on the surface of the fibers. The CEU resin does not contribute to such wet soiling. In fact, cotton fabrics treated with commercial methylol resins without additives have been found to be more resistant to wet soiling than are untreated control fabrics. A simple laboratory test for wet soiling has been adopted. Cloth swatches are soiled in a Launder-Ometer with a soap solution containing a small amount of carbon under controlled conditions. A quantitative estimation of the extent of soiling is obtained by means of a reflectometer. In this test, the variables—time, temperature, and concentration of carbon—affect the degree of soiling. Synthetic detergent, in place of soap, has little effect on soiling.

1666. **WASH-AND-WEAR: PROGRESS AND PROBLEMS.** Reid, J. D.; Reinhardt, R. M.; Kopacz, B. M.; and Fiori, L. A. Textile Industries *122* (11): 90–98. 1958.

A brief outline of the progress that has been made in developing wash-and-wear cottons is presented. Specifically, the existing problems are reviewed with the purpose of pointing to the contributions required from all segments of the industry to produce a truly wash-and-wear product. The contributions of yarn structures and fabric geometry as a sound basis for resin treatment are pointed out. Resin treatment involves such considerations as the effects of desizing, bleaching, washing, mercerizing, and dyeing. Proper selection of resin and catalyst and suitable curing and aftertreatments are also considered. Final contributions of garment construction are most important to produce the true cotton wash-and-wear garment. Through research and an understanding of all the problems, the cotton textile industry is fast approaching the production of a true wash-and-wear all-cotton garment.

1577. **NEW FINISHING TECHNIQUES FOR WASH-AND-WEAR COTTONS.** Reid, J. D.; and Reinhardt, R. M. Modern Textiles *39* (3): 61–68. 1958.

The development of crease-resistant fabrics, their present status, and their future outlook, are reviewed briefly. The resins and catalysts now in use are discussed, followed by an analysis of the mechanism of the crease-proofing process and a discussion of the application of resins to cotton yard goods. Some advantages and disadvantages of cotton wash-and-wear garments are described, such as the difficulty of making smooth seams and sharp, durable creases in the finished garment, and methods now under investigation to meet or avoid these problems. Recuring and treatment of the finished garment are the most promising methods now being tried. Great advances have been made in the production of true wash-and-wear cotton garments, and the authors think that a completely satisfactory method will soon be available.

1561. **THE APPLICATION OF RESIN FINISHES TO COTTON GARMENTS USING DRYCLEANING PLANT EQUIPMENT.** Graham, R. T.; Loibl, Fred; and Wiebush, J. R. Textile Research J. *28:* 252–56. 1958.

Preliminary results are given from a study of the application of a resin finish to cotton garments, using drycleaning plant equipment. Cotton fabric swatches of various constructions, including print cloth, denim, sateen, cord, broadcloth, gingham, corduroy, and suiting materials, were used. The object of the work was to impart wrinkle resistance and desirable permanent creases to cotton garments. A tentative procedure for the resin treatment has been devised that has proved effective on various weaves and weights of cotton fabrics. The cost of application of the resin finish to cotton cord suits in a drycleaning plant has been estimated.

1565. **DURABLE CREASING OF WRINKLE RESISTANT COTTON.** Reid, J. D.; Reinhardt, R. M.; and Kullman, R. M. H. Textile Research J. *28:* 242–51. 1958.

Research is underway at the Southern Regional Research Laboratory to improve cotton by resin treatment to strengthen its competitive position with respect to other fibers. In preliminary stages of the work, improved formulations and methods of curing produced garments that are truly wash-wear in that they may be machine laundered, dried, and worn without ironing. Attempts are now being made to perfect a finish aimed particularly at men's "no muss" summer-weight dress suits and slacks. Both fundamental and practical studies have been conducted on a "recuring" process by which cotton goods already treated with resin and cured are made into garments and aftercured by careful introduction of catalyst. The creases, pleats, cuffs, and so forth are then set by heat curing. Creases set by this method are not as durable to laundering as are those that can be set in the fabric on an initial cure; but they compare favorably with creases found in worsted wool garments. Two possible mechanisms for recuring are suggested, and evidence in favor of each hypothesis is given. Results on the recuring of both laboratory and commercially resin-treated cotton fabrics are reported.

1489. **AFTERMERCERIZATION OF METHYLOLMELAMINE RESIN-TREATED COTTON FABRICS.** Mazzeno, L. W., Jr., Reinhardt, R. M.; Markezich, A. R.; and Reid, J. D. Am. Dyestuff Reptr. *46:* 719–24. 1957.

Aftermercerization of methylolmelamine-treated 80 x 80 print cloth improves the tearing strength of the fabric as much as 20 percent and abrasion resistance up to 100 percent. Wrinkle-recovery angle is only slightly diminished by the treatment. Optimum conditions for this process are: Resin content, 6 to 10 percent; alkali concentration, 20 percent; time of mercerization, 20 minutes; and temperature of mercerization, 25° C. Durability of the improvements imparted by the alkaline treatments has been shown by laundering through six standard cycles by the AATCC Method No. 14–53 modified to use 160° F. as laundering temperature. A comparison of premercerized and aftermercerized, resin-treated fabrics shows that more benefit in strength properties is achieved with the aftermercerization process. Data are presented to qualitatively explain the action of the alkali on the resin-treated fabric.

1426. **STUDIES ON PERMANENT CREASING OF COTTON GARMENTS.** Reid, J. D.; Mazzeno, L. W., Jr.; Reinhardt, R. M.; and Markezich, A. R. Textile Research J. *27:* 252–59. 1957.

Investigations of the application of resin formulations to cotton garments for the purpose of imparting permanent creases have two phases—application to yard goods and application to finished garments. Resin curing is accomplished on the finished garment in both cases. Methods of application, procedures, and results are given for application of a dimethylol cyclic ethylene urea (CEU) formulation to swatches of fabric and to garments. A number of variables such as storage, possibilities of stripping, need for precautions in drying and curing, durability to laundering, effect of sizing, effect of catalysts, and results using related resins in varying the formulation are discussed. Ultimate objectives include cooperative work with other research agencies to utilize standard drycleaning equipment for commercial application of finishes suitable for white goods to impart permanent creases in cotton garments.

797. **CREASE-RESISTANT CLOTH FROM PARTIALLY CARBOXYMETHYLATED COTTON.** Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. Textile Research J. *22:* 792–97. 1952.

When resin treatments are applied to the acid form of partially carboxymethylated cotton cloth to produce crease-resistance, the carboxyl group supplies a built-in catalyst. This built-in catalyst makes the addition of catalyst unnecessary and in this way avoids the prepolymerization of resin baths that contain added catalysts. The high swellability of the modified cotton allows easier penetration of the resin-formers, larger pickup of resin, and production of cloth of equivalent crease-resistance that is superior in most other physical properties to unmodified, resin-treated cloth. The process of carboxymethylation (impregnation of cotton cloth with a weak solution of monochloroacetic acid followed by treatment with strong sodium hydroxide) is commercially feasible and can be carried out with ordinary textile equipment.

Flame Resistance

1818. **HOW MUCH WILL THPC FLAMEPROOFING COST?** McMillan, O. J., Jr. Textile Ind. *123* (7): 94–96. 1959.

Preliminary cost studies for the THPC-methylolmelamine treatment of cotton show that protection from flammability can be inexpensive. The resin treatment needed to impart the required degree of flame resistance has been estimated to cost as little as 15 cents per pound of product, based on a reasonable projected price of 70 cents per pound of THPC.

1827. **MAKING HOUSEHOLD FABRICS FLAME RESISTANT.** Reid, J. D.; Reeves, W. A.; and Frick, J. G., Jr. U.S. Dept. Agr. Leaflet No. 454, [n.p.] 1959.

Household methods of making cotton textiles flame resistant by use of borax, boric acid, and other mixtures are described.

1659. **PHYSIOLOGICAL AND BIOLOGICAL PROPERTIES OF APO AND APS, COTTON FLAME RETARDANTS. A LITERATURE REVIEW, WITH BIBLIOGRAPHY.** Drake, G. L., Jr.; Kopacz, B. M.; and Perkerson, F. S. U.S. Dept. Agr. ARS 72–14, 12 pp. 1958. (Processed.)

The publication lists 68 references relating to the physiological and biological properties of APO and APS, cotton flame retardants. The work also includes a brief review of the findings to date. In spite of the fairly large amount of work so far reported, not all of the physiological and biological properties of APO and APS are known as yet. Therefore, it is necessary to exercise normal care and caution in handling these new chemicals.

1713. **DEVELOPMENT OF DURABLE FLAME-RETARDANT FINISHES FOR COTTON.** Frick, J. G., Jr.; Arceneaux, R. L.; Leonard, E. K.; and Reid, J. D. WADC Technical Report 58–130, ASIA Document No. 206894.[1] 1958.

New methods for imparting a durable, flame-retardant finish to cotton fabrics were investigated. Primarily, methods were sought for the chemical attachment of phosphorus-containing groups to cellulose. Classes of compounds investigated include: Amides of phosphorus (V) acids; imides of phosphorus (V) acids; tetramethylphosphorodiamidic acid derivatives; phosphorus compounds containing epoxy groups; triazinylphosphonates; and phosphoroisothiocyanatidate derivatives. Also investigated were modifications of the phosphoric acid-urea process for the phosphorylation of cotton. The best finish developed was inferior in some respects to existing finishes. Some suggestions for future work are included.

1490. **AUTOMATIC IGNITION AND TIMING OF THE FLAME IN THE VERTICAL FIRE-RESISTANCE TEST.** Tallant, J. D. Textile Research J. *27:* 825–26. 1957.

Improvements in the method of applying the vertical flame test, widely used for determining the efficacy of flame retarding finishes for fabrics, are suggested. Since ignition and timing of the flame are automatic, tests are more precise. Construction and manipulation of the device are described.

1417. **FLAME RETARDANTS FOR COTTON USING APO- AND APS-THPC RESINS.** Reeves, W. A.; Drake, G. L., Jr.; Chance, L. H.; and Guthrie, J. D. Textile Research J. *27:* 260–66. 1957.

A new group of polymers made by reacting tris(l-aziridinyl)phosphine oxide, referred to as APO, or tris(l-aziridinyl)phosphine sulfide, referred to as APS, with tetrakis(hydroxymethyl)phosphonium chloride, referred to as THPC, are good permanent-type flame retardants for cotton. Application of APO- or APS-THPC resins to textiles consists of padding fabric in an aqueous solution of the compounds, drying, curing at about 140° C. for about 5 minutes to polymerize the compounds, and then rinsing the fabric to remove any unpolymerized material. About 8 percent of the resins in 8-oz. cotton twill or sateen is adequate to make the fabric pass the vertical flame test before or after 15 launderings with synthetic detergents followed by an acid fluoride sour after each laundering. The flame resistance is also very durable to boiling alkaline soap solutions. Hand and strength are only slightly different from those of untreated fabric, and the fabric is resistant to rot and mildew.

1500. **AN INVESTIGATION OF SILICON COMPOUNDS AND DIBROMOPROPYL PHOSPHATES AS FLAME RETARDANTS FOR COTTON. PART II. AN INVESTIGATION OF SILICON COMPOUNDS AS FLAME RETARDANTS FOR COTTON FABRICS.** Frick, J. G., Jr.; Moore, H. B.; and Reid, J. D. Textile Ser. Rept., QM Research and Eng. Command No. 100: 15–23. 1957.

Several silicon compounds potentially capable of making durable finishes were investigated as flame retardants for cotton. The compounds studied included polysiloxanes, acetoxysilanes, and silyloxy-phosphorus polymers. None was effective enough to be a practical flame retardant for cotton fabrics. Compared to existing durable finishes, the add-ons required for flame resistance were excessive.

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[1] This report has been released to the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C., for sale to the general public.

1499. **AN INVESTIGATION OF SILICON COMPOUNDS AND DIBROMOPROPYL PHOSPHATES AS FLAME RETARDANTS FOR COTTON. PART I. THE USE OF DIBROMOPROPYL PHOSPHATES AS FLAME RETARDANTS FOR COTTON.** Reid, J. D.; Reinhardt, R. M.; and Daul, G. C. Textile Ser. Rept., QM Research and Eng. Command No. 100: 1–14. 1957.

The preparation and some of the properties of mono-, bis-, and tris(dibromopropyl) esters of phosphoric acid have been described. The ammonium salts of mono- and bis(dibromopropyl)phosphoric acid apparently form polymers with trimethylolmelamine that have definite phosphorus-to-bromine ratios that change after curing on cotton cloth. These polymers have been formed on cotton fabric by application of the monomers to confer excellent flame- and glow-resistance properties to the cloth. Cloth treated with these compounds will withstand solvent extraction and from six to nine severe launderings. Crease-resistance is also imparted to the cloth; and changes in hand, tear-resistance, and other physical properties are of the same order as those obtained when trimethylolmelamine is used alone, as in commercial crease-proofing and dimensional stability treatments. The tris(dibromopropyl) ester of phosphoric acid was applied by two methods in conjunction with trimethylolmelamine. One method consisted of applying the ester in organic solvent solution followed by treatment with trimethylolmelamine; the other method involved making an emulsion of the ester with triethanolamine oleate and mixing the emulsion with a solution of trimethylolmelamine prior to its application to cloth. Cloth treated by either of these methods is flame- and glow-resistant and will withstand about nine launderings but not organic solvent extraction. Hand and tear-strength are not materially affected by these treatments.

1497. **IMPROVEMENT OF HEAT ENDURANCE OF COTTON BY TREATMENT WITH DICYANDIAMIDE.** Sloan, W. G.; and Buras, E. M., Jr. Am. Dyestuff Reptr. *46:* 529–32. 1957.

An inexpensive treatment to improve the heat endurance of cotton consists of impregnating in an aqueous solution of dicyandiamide, padding or centrifuging to the desired pickup, and drying. Techniques are described for treating raw stock, yarns, and fabrics. Heat endurance testing is discussed, and results of tests are tabulated. The treatment was found to improve the heat endurance of gray, dyed, and THPC-resin-treated cotton yarns approximately 100 percent. Scoured cotton fabrics were improved approximately 50 percent. The effect of the dicyandiamide treatment on cyanoethylated, partially acetylated cotton, and aminized cotton, as well as on acetate and viscose rayon, is also discussed. The dicyandiamide finish is not stable if the fabric is washed in water.

1354. **FLUORINE AND IODINE COMPOUNDS AS FLAME RETARDANTS FOR COTTON.** Frick, J. G., Jr.; Reid, J. D.; and Moore, H. B. Textile Research J. *26:* 525–28. 1956.

Fluorine and iodine compounds, both organic and inorganic, were tested as flame retardants for cotton. Comparison with bromine and chlorine compounds showed that the effectiveness of the halogens, on an equal weight basis, increases in the order: Fluorine, chlorine, bromine, and iodine; the last two were about equally effective.

1292. **EMULSION POLYMERIZATION OF TRIALLYL PHOSPHATE WITH HALOMETHANES.** Frick, J. G., Jr.; Weaver, J. W.; Arceneaux, R. L.; and Stansbury, M. F. J. Polymer Sci. *20:* 307–15. 1956.

Triallyl phosphate has been polymerized in emulsion by itself and with four halogenated methanes: Carbon tetrabromode, bromoform, bromotrichloromethane, and carbon tetrachloride. Of the four halomethanes, carbon tetrachloride enters telomer formation only to a slight extent, and bromoform and carbon tetrabromide enter to the greatest extent. In most cases, a product consisting of two distinct fractions was formed—a solid-insoluble polymer and a liquid-soluble polymer. The latter is of only a low degree of polymerization, ranging from 1.0 to 2.3 phosphate units. In the course of the reaction, the soluble fraction is formed first and then is partially converted to the insoluble fraction by crosslinking. The polymerization of triallyl phosphate with bromoform received the most study. In this case the ratio of insoluble to soluble fraction can be changed by varying the amount of initiator and the ratio of bromoform to phosphate. A molar ratio of bromoform to triallyl phosphate greater than 2.0 yields only monomeric addition products. By the proper choice of conditions, a very stable emulsion of a polymer-containing phosphorus and bromine can be obtained. This emulsion is suitable for direct application to cotton textiles in order to produce flame-resistant fabrics.

1264. **COTTON MADE FLAME-RESISTANT WITH BROMINE-CONTAINING PHOSPHONITRILATES IN COMBINATION WITH THPC RESINS.** Hamalainen, C.; Reeves, W. A.; and Guthrie, J. D. Textile Research J. *26:* 145–49. 1956.

A permanent-type flame retardant based on a bromoform adduct polymer of allyl phosphonitrilate in combination with THPC resin has been developed for use with cotton fabrics. The combination flame retardant is applied to fabrics from aqueous emulsion, using conventional textile finishing equipment. The flame retardant is very efficient; 8-oz. twill and sateen are made highly flame-resistant with as little as 13-percent resin add-on.

1261. **BROMINE-CONTAINING PHOSPHONITRILATES AS FLAME RETARDANTS FOR COTTON.** Hamalainen, C.; and Guthrie, J. D. Textile Research J. *26:* 141–44. 1956.

Bromine-containing derivatives of phosphonitrilic chloride were investigated as possible durable flame retardants for cotton fabrics. These, including brominated allyl phosphonitrilate, 2,3-dibromopropyl phosphonitrilate, and the bromoform adduct polymer of allyl phosphonitrilate, were applied to cotton fabrics as polymeric products from organic solvent or from aqueous emulsions. Evaluation tests on tear strength and on the durability of the flame resistance to laundering were made.

1263. **A COMPOUNDED FLAME RETARDANT FOR COTTON FABRICS.** Reid, J. D.; Frick, J. G., Jr.; and Arceneaux, R. L. Textile Research J. *26:* 137–40. 1956.

A combination of two existing flame retardants, THPC and the bromoform-triallyl phosphate polymer, produces a flame retardant finish for cotton that is superior to that of either finish alone. Samples were subjected to vertical flame and match tests. Sateen and twill, 8-oz. weight, were classed "excellent" after 6 launderings, and "good" after 12 launderings. Tear resistance varied with type of fabric treated. Weight add-ons of about 18 percent were required on 8- to 9-oz. fabrics for a high degree of flame resistance. The two treatments were applied simultaneously by the method used for THPC alone, with a simple finishing procedure.

1271. **REVIEW OF THREE RECENT DEVELOPMENTS IN FLAME-RETARDANT TREATMENTS FOR COTTON.** Reid, J. D. Textile Research J. *26:* 136. 1956.

This is a brief introduction to three papers on flame retardant treatment of cotton. Two figures are included, showing the formation of the THPC polymer from tetrakis(hydroxymethyl)phosphonium chloride and methylomelamine, and the BAP polymer from bromoform and triallyl phosphate.

1293. **INTERMEDIATE FOR FLAME-RESISTANT POLYMERS—REACTIONS OF TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM CHLORIDE.** Reeves, W. A.; and Guthrie, J. D. Ind. Eng. Chem. *48:* 64–67. 1956.

Tetrakis(hydroxymethyl)phosphonium chloride (THPC) was used to form polymers by reaction with amines, phenols, polybasic acids, and anhydrides. In many of the reactions, the similarity of THPC to aqueous formaldehyde or primary alcohols was noted. Many varieties of polymers were made by reacting various materials with THPC. The principal advantage of using THPC instead of formaldehyde or an alcohol to form the polymer appears to be that the resins formed are flame- and glow-resistant in contrast to those formed with the customary polymerizing agents. Experimental polymerizations for THPC with cetylamine, urea, urea and melamine, melamine, ethylenimine, phenol, phloroglucinol, and chlorendic anhydride are described.

1199. **LABORATORY PREPARATION OF TETRAKIS-(HYDROXYMETHYL)-PHOSPHONIUM CHLORIDE.** Reeves, W. A.; Flynn, F. F.; and Guthrie, J. D. J. Am. Chem. Soc. 77: 3923. 1955.

Because of interest in tetrakis(hydroxymethyl)phosphonium chloride (abbreviated THPC) as a flame retardant for textiles, an improved method of preparation was desired. THPC may be made by reacting phosphine with an aqueous formaldehyde-hydrochloric acid solution. Phosphine was found to react rapidly in this solution at room temperature and to be more soluble at 25° C. than at 80° C., the temperature used in the old method. At the lower temperatures, explosions were eliminated. Reaction was rapid; the phosphine produced by 30 g. of aluminum phosphide was absorbed and reacted with 100 g. of formaldehyde-hydrochloric acid solution in less than 1 hour. Phosphine was made by reacting aluminum phosphide with water at room temperature, but other methods of making it may be used. The new method produced 85- to 90-percent yield of THPC.

1197. **EFFECT OF FLAMEPROOFING AGENTS ON COTTON CELLULOSE.** Schuyten, H. A.; Weaver, J. W.; and Reid, J. D. Ind. Eng. Chem. *47:* 1433–39. 1955.

A flame retardant applied to cotton cellulose behaves as a catalytic agent when the cloth is ignited, changing the course and speed of the reactions. That decomposition of the cellulose is accelerated and gas production decreased is evidenced by the large amount of carbonaceous material left behind. Although the gases produced are flammable, they are evolved at a much lower temperature with treated than with untreated cloth and are liberated and dissipated at temperatures probably too low for ignition. Similar results with regard to speed of decomposition and amount of char produced were obtained in a study of nine different flame retardants. That the reaction in flameproofing is a dehydration of cellulose is shown by carbon and hydrogen analyses of the char residue. Moreover, examination of the charred residue of cloth flameproofed with several organic phosphorus resins has shown the presence of acids of phosphorus. Such agents (Lewis acids) bring about the catalytic dehydration of alcohols, and the presence of such agents suggests a similar mechanism in the decomposition of flameproofed cellulose.

1196. **DISTRIBUTION OF PHOSPHORUS DURING PROCESSING AND CHARRING OF THPC-RESIN-TREATED COTTON FABRIC.** Stansbury, M. F.; and Hoffpauir, C. L. Am. Dyestuff Reptr. *44:* 645–47, 676. 1955.

The distribution of phosphorus during laboratory-scale processing and charring of a typical THPC-resin-treated flame-resistant cotton fabric was investigated. Phosphorylated cotton was also charred under the same conditions. Relatively small amounts of phosphorus compounds were evolved during the drying and curing steps of the THPC process. Considerably larger quantities were removed in the washing step. Approximately 0.0003 and 0.0002 percent of phosphine-phosphorus were found for the drying and curing steps, respectively, on the basis of washed, cured fabric weight. A large percentage of the total phosphorus present in the THPC-treated and phosphorylated fabric remained in the fabrics after charring. A small amount of phosphine was evolved when THPC-treated fabric was charred under the experimental conditions employed, whereas little or none was evolved from phosphorylated fabric.

1138. **APPLICATION OF THE THPC FLAME-RETARDANT PROCESS TO COTTON FABRICS.** Guthrie, J. D.; Drake, G. L., Jr.; and Reeves, W. A. Am. Dyestuff Reptr. *44:* 328–32. 1955.

Tetrakis(hydroxymethyl)phosphonium chloride (abbrevited THPC) is the key chemical used in a process that imparts flame resistance to cotton fabrics. An aqueous solution containing THPC, methylolmelamine, urea, and triethanolamine is applied with a padder. Drying, curing, and washing follow. A softener may be incorporated into the treating solution. The functions of each of the components of the system are discussed in relation to changes in the formulation of the treating solution to meet various requirements. Laboratory applications of the process to various fabrics, such as marquisette, heavy belting duck, twill, sateen, blanket fabrics, and napped fabrics are described.

1130. **FLAME-RESISTANT COTTON FABRICS: AN EMULSION TREATMENT USING AN ORGANIC PHOSPHORUS-BROMINE POLYMER.** Frick, J. G., Jr.; Weaver, J. W.; and Reid, J. D. Textile Research J. *25:* 100–5. 1955.

Cotton fabrics that will retain their flame resistance through at least 12 launderings and show little change in textile properties have been prepared by a newly developed process. The process consists of the preparation in emulsion of an organic polymer from bromoform and triallyl phosphate. This emulsion can be applied directly to the fabric on conventional equipment common in textile finishing plants. Cotton fabrics of 8- or 9-oz. weight require 18- to 22-percent pickup for desirable flame resistance. The most noticeable effect of the treatment on the textile properties of the fabric is a reduction in tear resistance; the difference in tear resistance becomes smaller as the fabric is subjected to repeated launderings, because the treated fabric does not lose strength in laundering as rapidly as does untreated fabric.

1058. **SPECTROPHOTOMETRIC EVIDENCE OF POLYMERIZATION IN PEROXYTITANIC ACID SOLUTIONS.** Reeves, R. E.; and Jonassen, J. B. J. Am. Chem. Soc. *76:* 5354–56. 1954.

Absorption characteristics of peroxytitanic acid solutions in various concentrations have been investigated as part of a study of the flameproofing potentialities of titanium compounds. Polymerization of peroxytitanic acid is a possible explanation of the fact that the light absorption of peroxytitanic acid solutions obeys Beer's law only at rather great dilutions. A series of closely related polymers forms in moderately concentrated solutions of the acid.

1057. **EVIDENCE OF POLYMERIZATION IN TITANIUM (IV) SULFATE SOLUTIONS.** Reeves, R. E.; and Blouin, F. A. J. Am. Chem. Soc. *76:* 5233–35. 1954.

During studies of the reaction of titanium (IV) salts with cellulose and with simpler organic molecules in developing cotton flameproofing processes, differences were observed in the behavior of titanium tetrachloride and titanium (IV) sulfate solutions. Studies of the titanium tartrate complexes to understand better the differences between the behavior of titanium chloride and titanium sulfate solutions have cast new light on the behavior of aqueous solutions of titanium sulfate.

985. **2,5-DIMETHYL-D-GLUCOFURANOSE AND TWO NEW CRYSTALLINE DERIVATIVES.** Reeves, R. E. J. Am. Chem. Soc. *76:* 934. 1954.

In research to develop flame-retardant treatments of cotton by reaction with titanium compounds, one of the model glucosides used was methyl 2,5-dimethyl-α-D-glucofuranoside. Two new crystalline derivatives of this glucoside are 2,5-dimethyl-alpha-D-glucofuranoside, and methyl 2,5-dimethyl-3,6-diacetyl-alpha-D-glucofuranoside. Upon hydrolysis of the methyl glucoside, the reducing sugar, 2,5-dimethyl-D-glucofuranose, was obtained in solution; but it could not be prepared in crystalline form. Some of its properties have been determined.

1008. **SOME THEORETICAL ASPECTS OF THE FLAMEPROOFING OF CELLULOSE.** Schuyten, H. A.; Weaver, J. W.; and Reid, J. D. Advances in Chem. Ser. 9. Fire Retardant Paints: 7–20. June 1954.

Several theories of thermal decomposition of treated and untreated cellulose, the latter also involving burning, which others have proposed to explain how flaming is inhibited in the many processes used to flameproof cloth or cellulosic materials, are considered. The study leads to the conclusion that dehydration, aided by accelerated gas production through a Lewis acid-base interaction by way of a carbonium ion or carbon ion mechanism, explains the behavior of all known flameproofing agents. Much of the reasoning involved in this theory should apply also to the flameproofing of wood.

1074.1. **FLAMEPROOFING WITH THPC.** Reeves, W. A.; and Guthrie, J. D. Dyer *111:* 567–70. 1954.

A rather unusual chemical compound has been found that can be applied in combination with other chemicals to cotton fabric to make it permanently flame resistant. This crystalline compound is tetrakis(hydroxymethyl)-phosphonium chloride (abbreviated "THPC"). The flameproofing treatment can be applied on standard chemical finishing equipment. An aqueous solution of THPC, trimethylolmelamine, urea, and triethanolamine, is applied to fabric with a padder with a tight nip roll pressure to keep the wet pickup at a minimum. The fabric is then dried at a relatively low temperature, cured at an elevated temperature, and washed by any of the usual washing procedures. A softener should be applied to the treated fabric.

936. **FLAMEPROOFING OF COTTON WITH THPC-RESINS.** Reeves, W. A.; and Guthrie, J. D. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–364. 11 pp. 1953. (Processed.) Republished: THPC, NEW FLAME-RESISTANT TREATMENT IS PERMANENT AND EFFECTIVE. Textile World *104* (2): 101, 176–82. 1954. Also, IMPARTING FLAME-RESISTANCE TO COTTON BY USE OF THPC-RESINS. Textile Weekly *53* (1367): 1618, 1620, 1622, 1640. 1954.

Tetrakis(hydroxymethyl)phosphonium chloride, (HOCH$_2$)$_4$PCl (abbreviated "THPC"), is a rather unusual crystalline compound that can be applied in combination with other chemicals to make cotton permanently flameproof. The treatment can be applied on standard chemical-finishing equipment. Eight-ounce twill containing about 16 percent of THPC-resin passes the standard vertical flame test. The resin is permanent to laundering; in addition, treated fabric is glowproof. Considerable wrinkle resistance and rot or mildew resistance are imparted.

779. **TRIS-(BETA-CHLOROALLYL) PHOSPHATE.** Reinhardt, R. M. J. Am. Chem. Soc. *74:* 1093–94. 1952.

Tris-(beta-chloroallyl) phosphate has been prepared by reacting phosphorus oxychloride with beta-chloroallyl alcohol under conditions similar to those employed by Whitehill and Barker for the preparation of triallyl phosphate.

404. **COMPOSITION OF TWO TYPES OF CELLULOSE PHOSPHATES.** Reid, J. D.; Mazzeno, L. W., Jr.; and Buras, E. M., Jr. Ind. Eng. Chem. *41:* 2831–34. 1949.

This paper describes experiments conducted in an effort to elucidate the structure of phosphates of cellulose prepared by the commercial urea phosphate method of flameproofing cloth and by the pyridine-phosphorus oxychloride method. By electrometric titration it is shown that the combined phosphorus in the cellulose phosphate prepared by the treatment of cellulose with urea phosphate is probably entirely in the form of a monosubstituted phosphate ester. There is no evidence of the formation of other more highly substituted products. The structure of cellulose phosphate prepared by the treatment of cellulose with phosphorus oxychloride-pyridine mixture is similar, except that, in a typical sample, approximately 23 percent of the phosphorus can be accounted for as a disubstituted phosphate ester. The chlorine present in this product is probably attributed directly to the carbons of the glucose units. A small amount of nitrogen, presumably due to pyridine, is found in typical samples.

405. **PREPARATION AND PROPERTIES OF CELLULOSE PHOSPHATES.** Reid, J. D.; and Mazzeno, L. W., Jr. Ind. Eng. Chem. *41:* 2828–31. 1949.

Various methods of phosphorylating cellulosic materials have been investigated. A method using phosphorus oxychloride and pyridine as the phosphorylating agents has been adopted, and a number of cellulosic products containing phosphorus and chlorine have been prepared and analyzed. Cloth phosphorylated by the above process is substantially flameproof and glowproof but suffers so great a loss in tensile strength that it is impractical for garment manufacture. Much of this degradation is avoided in preparing samples by the urea-phosphoric acid method of phosphorylation. Degradation is very slight in these products. Incorporation of cellulose phosphates into a successful flameproofing formula reduces the afterglow, but too large an amount is required to achieve complete extinction of the afterglow. Data are included giving the effects of change of time, temperature, and molar ratio on the phosphorylation of cellulose, hydroxymethylcellulose, ethylcellulose, and cellulose acetate.

380. **SOME NEW POLYHALOGENATED PHENYL ISOCYANATES.** Georges, L. W.; and Hamalainen, Carl. J. Am. Chem. Soc. *71:* 743. 1949.

The preparation of polyhalogenated phenyl isocyanates, used experimentally in the production of fire-resistant cotton textiles by a process recently patented (patent No. 2,428,843), is described. These isocyanates are believed to be new compounds.

183. **DURABLE FLAMEPROOFING SUITABLE FOR COTTON OUTER GARMENTS.** Campbell, K. S.; and Sands, J. E. Textile World *96* (4): 118–19, 222, 226. 1946.

A flameproofing method is described that is based on the use of an insoluble flameproofing agent consisting of a combination of a resin of proper chlorine content and an antimony compound employed with an emulsion technique and the incorporation of a water-soluble urea-formaldehyde resin monomer. A typical formula is given for 2.5 yards per pound 28-inch cotton drill, and its mechanical application to the fabric is described. The flame resistance achieved is well within the requirements of Federal Specification CCC–D–746. After 24 individual 30-minute launderings at 160° to 170° F. in a commercial-type laundry machine, the treated fabric did not ignite when subjected to a lighted match. Afterglow persists generally from 3 to 4 minutes.

Heat, Rot, and Weather Resistance

1834. **POTENTIAL MARKETS FOR PARTIALLY ACETYLATED COTTON.** Barlow, F. D., Jr.; Cooper, A. S., Jr.; and Vix, H. L. E. (In cooperation with Agricultural Marketing Service.) U.S. Dept. Agr. AMS–324, 22 pp. 1959.

Improved properties resulting from partial acetylation of cotton are resistance to rot, mildew, heat, and scorch. The opportunity for commercializing PA cotton, from a cost standpoint, is confined primarily to utilizing the properties of scorch and heat resistance, important properties for commercial laundry textiles and home ironing-board covers. Service evaluations in which fabrics were exposed to sustained temperatures of 300° F. or more indicated that the service life of PA cotton was about four times that of untreated cotton. The estimated costs of PA cotton based on pilot-plant and commercial operation further provided a basis for assuming a favorable competitive position for PA cotton versus untreated cotton and other materials used in commercial laundry textiles. Based on the National Cotton Council's 1956 statistics for cotton consumed in the laundry industry and cotton's share of this market, it was estimated that the market potential for PA cotton would be between 17,000 and 27,500 equivalent bales of cotton. The market potential for PA cotton for use as home ironing-board covers is estimated to be 2,225 bales.

1843. **USE OF TRIFLUOROACETIC ANHYDRIDE IN PARTIAL ACETYLATION OF COTTON CELLULOSE.** Hamalainen, Carl; Wade, R. H.; and Cruz, M. D. Textile Research J. *29:* 821–26. 1959.

Trifluoroacetic anhydride (TFAA) has been found to be an effective esterification promoter in the preparation of experimental quantities of partial cellulose acetates in which the fibrous structure of the original cotton is retained. In this reaction TFAA acts as an impellent, and no additional catalyst is required. A method of preparation has been devised; and the effects of time, temperature, and molar ratio of the components in the reaction system have been studied. Optimum reaction conditions are mild with no great degradative effects. Cotton in the form of yarn has been reacted, and the composition and physical characteristics of the modified yarns have been determined.

1811. **DESIZING, SCOURING, AND BLEACHING IMPROES COTTON FOR OUTDOOR USE. (A Report of the CPAI-SURDD Cooperative Research Program.)** Reeves, W. A.; Robinson, H. M.; Brysson, R. J.; and Berard, W. N. Canvas Prods. Rev. *35* (7): 32–33, 48. 1959.

Data are presented to demonstrate that wet-processing treatments such as desizing, scouring, and bleaching tend to make cotton fabrics less susceptible to mildew when exposed outdoors. These treatments reduce the amount of foreign substances available for mildew support. The cotton fabrics used in the studies included standard 10.10-oz. duck, 5.2-oz. oxford, and 3.25 and 2.85 drill. In each case the gray fabric was compared with the same fabric that had undergone one or more of the wet-processing steps. Comparisons of vinyl-coated gray and vinyl-coated scoured and bleached drill fabrics were made. In all instances, the wet-processed fabrics showed less tendency to mildew and had higher strength retention values after exposure than did the gray fabrics.

1840. **A SURDD-CPAI RESEARCH REPORT: BIS(TRIBUTYLTIN)OXIDE USED IN OUTDOOR FABRICS.** Reeves, W. A.; Berard, W. N.; Leonard, E. K.; and Brysson, R. J. Canvas Prods. Rev. *35* (4): 32–33. 1959.

The use of bis(tributyltin)oxide (referred to as TBTO) as a mildew inhibitor for outdoor fabrics was evaluated in soil-burial and weather-exposure tests. TBTO was deposited in lightweight cotton print cloth and in 10-oz. cotton canvas. Print cloth with 0.1 percent of TBTO retained only 29 percent of its original strength after 4 days in the soil bed, and print cloth without any TBTO retained 14 percent after 4 days. Canvas treated with 0.01-percent TBTO (equivalent to that found in a commercially treated canvas) retained only 18-percent strength after 3 weeks' soil burial, and the untreated scoured duck retained 3-percent strength after 7 days. The reduction of microbial action is not great even when the fabric contains 1 to 2 percent of the tin compound. Print cloth containing 0.1 percent of TBTO and exposed outdoors had more mildew damage than did fabric treated with lower concentrations of the tin compound, and even more damage than did the scoured control fabric. Ten-oz. duck containing TBTO and a water repellent became heavily infested with mildew upon outdoor exposure. A commercially available and widely used base fabric and an experimentally treated canvas exhibited considerably more resistance to mildew than did TBTO-treated fabrics when exposed outdoors.

1820. **THE IMPROVEMENT OF SELECTED PHYSICAL PROPERTIES OF PARTIALLY ACETYLATED COTTON FABRICS.** Cooper, A. S., Jr.; Cruz, M. D.; Murphy, A. L.; and Cashen, C. F. Am. Dyestuff Reptr. *48* (20): 43–49. 1959.

Partially acetylated (PA) cotton fabrics produced by the usual procedures have reduced resistance to flex abrasion and tearing, which may limit their usefulness in some applications. However, these physical properties can be improved by the addition of fatty acids, higher than lauric, to the acetylating bath; by premercerization; or by addition of softening and lubricating agents. Test results indicate that it is possible by treating to obtain PA cotton products that have greater flex endurance and tear strength after heating for 7 days at 160° C. than do untreated PA cottons prior to heating.

1737. STUDIES ON PIGMENT IMPREGNATED FABRICS EXPOSED TO WEATHER—A CPAI-SURDD RESEARCH REPORT. Brysson, R. J.; and Gautreaux, G. A. Canvas Prods. Rev. *34* (12): 38–40, 49, 54, 56, 58, 62, 64. 1959.

Data are presented to show the effect of pigment dyeing on the weather durability of cotton canvas and cotton 80 x 80 print cloth exposed for 12 months. Effects of pigment on biological growth, as determined by visual examinations, are given. Work in progress is outlined.

1726. MECHANICAL BEHAVIOR OF CYANOETHYLATED COTTON TEXTILES. Conrad, C. M. Textile Research J. *29:* 287–302. 1959.

A rather detailed study has been conducted at the Southern Regional Research Laboratory, as well as at other places, on the textile properties of cyanoethylated cotton. For the most part, the studies have been concerned with improvements in rot and heat resistance and a comparison of such improvements with those resulting from acetylation of cotton. Various merchanical properties, including breaking strength, knot strength, tearing strength, ultimate elongation, tensile and flexural stiffness, toughness, elastic recovery, wrinkle recovery, and flex and flat abrasion resistance, have been measured. While many of these data have been published, they are in most cases reported incidentally and with little effort at completeness. The results are expressed in varying units, thus limiting their ready comparisons; and they are widely dispersed in many papers and therefore are not readily accessible. It is the purpose of the present report to assemble the mechanical data on fibers, yarns, and fabrics; to express them in consistent units; and to interpret them in terms of degree of cyanoethyl substitution, conditions of reaction, textile products involved, and fine structure of the fiber. The report also points out the still unexplored areas of chemical substitution, textile product, and conditions of treatment that need further study if an adequate picture of the mechanical behavior of cyanoethylated cotton is to be provided.

1731. PARTIALLY ACETYLATED (PA) COTTON—A STAFF-INDUSTRY REPORT. Anderson, E. V.; and Cooper, A. S., Jr. Ind. Eng. Chem. *51:* 608–14. 1959.

Special properties can be built into cotton by chemically modifying the fiber. Of the many chemical treatments studied at Southern Utilization Research and Development Division, partial acetylation has received most attention. Most important properties of PA cotton are its superior mildew, rot, heat, and scorch resistance, compared to the resistance of untreated material. Cotton is acetylated by reacting cellulose hydroxyls with acetic anhydride in the presence of perchloric acid. The Southern Regional Research Laboratory has developed both a batch and a continuous process to acetylate cotton yarn and fabric. Proctor Electric Company is the only American commercial producer of PA cotton, and it uses the batch process to make material for home ironing-board covers. Most promising market for PA cotton is the laundry industry.

1730. PARTIAL ACETYLATION OF COTTON—COST ANALYSIS APPLICATION. Decossas, K. M.; McMillan, O. J., Jr.; Cooper, A. S., Jr.; Koltun, S. P.; Keating, E. J.; and Pollard, E. F. Ind. Eng. Chem. *51:* 615–18. 1959.

This cost analysis shows that costs for partially acetylating cotton vary considerably with variations in annual production and method of processing. For example, the unit manufacturing cost for hypothetical annual production of 34,000 pounds of PA yarn by batch processing is $1.18; but, as production increases, the unit cost declines rapidly to as low as 19.1 cents per pound of product at an annual production of 4,796,000 pounds. For a comparable production of yarn using continuous operations, the unit-manufacturing cost is an estimated 16.4 cents per pound, or 2.7 cents per pound less. For a hypothetical production of 61,500,000 pounds of PA yarn by the continuous method, unit-manufacturing costs are estimated to be as low as 14.2 cents per pound of product. For fabric processing lower unit costs from continuous processing would appear to be realized above the capacity of four jigs. Minimum prices were calculated to be as low as 60.9 cents per pound of yarn product and 76.7 cents per pound of fabric product, on the basis of 40-percent return on fixed capital investment before taxes.

1654. HOW MUCH WILL P. A. COTTON COST? (Preliminary Study of the Manufacturing and Chemical Costs of Partially Acetylating Cotton.) Gardner, H. K., Jr.; Buras, E. M., Jr.; Decossas, K. M.; Cooper, A. S., Jr.; Keating, E. J.; and McMillan, O. J., Jr. Textile Ind. *122* (9): 100–4. 1958.

In recent years, considerable progress has been made in the chemical modification of cotton. Processes for the partial acetylation of cotton yarn and fabric were developed at the Southern Utilization Research and Development Division as a part of a research program to expand cotton utilization in products having specific properties. Partially acetylated cotton has outstanding resistance to deterioration by micro-organisms and heat, and it has been found to have unusually long service life in various applications such as sandbags, commercial laundry press cloths, household ironing-board covers, and water-softener bags. This paper gives investment costs, operating expenses, and estimated service charges and break-even points at two profit levels for hypothetical partial acetylation installations. The estimated manufacturing cost for partially acetylating cotton yarn to 15-percent acetyl content in a continuous process, involving processing about 54 million pounds of scoured yarn annually with reasonable chemical recovery, is 14.2 cents per pound of product.

1658. PARTIAL ACETYLATION OF COTTON: PRELIMINARY COST STUDIES. Gardner, H. K., Jr.; Buras, E. M., Jr.; Decossas, K. M.; Cooper, A. S., Jr.; Keating, E. J.; and McMillan, O. J., Jr. U.S. Dept. Agr. ARS 72–13, 13 pp. 1958. (Processed.)

This publication presents the same information as that covered by No. 1654.

1568.
(Pt. I)
1569.
(Pt. II) **THE EFFECT OF PIGMENTS ON COATED CANVAS EXPOSED TO WEATHER.** Brysson. R. J.; Berard, W. N.; and Bailey, J. V. Canvas Prod. Rev. Part I *33* (8): I–IV, V–VII (Separately paged insert fol. p. 30). 1958. Part II *33* (9): 30–31, 46–49. 1958.

Systematic tests were conducted to determine the effects of various classes of pigments on coated canvas exposed to weather. Of approximately 4,000 different pigments available to coatings manufacturers, 126 pigments, representing 96 separate classifications, were used in the experiments. Duck treated with urea-formaldehyde and copper-8-quinolinolate was used as a control for all the tests. Pigments were classified as white, extender, iron oxide, green, red and maroon, blue, black, orange, and yellow; and miscellaneous pigments and metallic powders and flakes. The orange group rated highest, with strength retention of 84 percent for canvas coated with chrome yellow plus orange; 85 percent for orange lake, dinitraniline orange, and basic zinc chromate; and 91 percent for molybdate orange, the highest rating for any of the pigments tested. Burnt sienna rated 86 percent; and hydrated chromium oxide, a green, was high among the cool colors, with 83 percent. The pigments were also rated on retention of color at the end of the weathering period, the ratings being made on the basis of poor, fair, or good color retention.

1563. CONTINUOUS CYANOETHYLATION OF COTTON YARNS. Janssen, H. J.; DuPré, A. M., Jr.; Haydel, C. H.; Seal, J. F.; and Vix, H. L. E. Ind. Eng. Chem. *50:* 76–79. 1958.

A method and apparatus for the continuous cyanoethylation of cotton yarns were investigated. The aim was to avoid excessive losses of reagent to byproduct formation, one of the principal obstacles to the commercialization of the cyanoethylation process. Such losses were considerably reduced, and the products were found to be superior in breaking strength and heat resistance to those cyanoethylated by more conventional procedures.

1663. TOPOCHEMICAL MECHANISMS INVOLVED IN THE PREPARATION AND DEACETYLATION OF PARTIALLY ACETYLATED COTTONS. Bailey, A. V.; Honold, Edith; and Skau, E. L. Textile Research J. *28:* 861–73. 1958.

Iodine sorption and moisture sorption data and some density, X-ray, and infrared data have been obtained on partially acetylated (PA) cotton before and after progressive deacetylation with 2 N hydrochloric acid or with N/2 sodium hydroxide. The results substantiate the theory that in the partial acetylation of cotton the amorphous regions are acetylated first. They also show that deacetylation of PA cottons by these two reagents proceeds by different mechanisms. With hydrochloric acid, the acetylated amorphous cellulose is deacetylated more or less completely throughout the fiber before the acetylated crystalline is attacked. With sodium hydroxide, both are deacetylated simultaneously with little or no selectivity so that deacetylation proceeds annularly from the surface of the fiber inward. The properties of the original PA cottons differed markedly from those of the same acetyl content obtained by deacetylation. The properties depended further on the reagent used for deacetylation and on the acetyl content before deacetylation. These differences in properties can be attributed to differences in the proportions and distribution of amorphous, crystalline, acetylated amorphous, and acetylated crystalline cellulose within the fiber and also to differences in the fine structure, degree of lateral order, and stress patterns resulting from the inhomogeneity of the volume changes that take place during acetylation or deacetylation.

1571. HEAT EVOLUTION DURING THE ACETYLATION OF COTTON. Greathouse, L. H.; Janssen, H. J.; and Haydel, C. H. Ind. Eng. Chem. *50:* 97–102. 1958.

To facilitate control of the process of partial acetylation, reliable information was required on the heat evolved in the reaction of acetic anhydride with cotton cellulose to the extent of one degree of acetyl substitution. To accomplish this, it was necessary to eliminate water from the system to avoid heat from the hydrolysis of acetic anhydride. The total amount of heat evolved is uniformly about 106 calories per gram of cotton per degree of substitution, although this is released much more slowly with the raw than with the purified cotton. A technique has been proposed for following acetylation by heat evolved and for stopping the reaction at a selected point.

1662. SIMPLIFIED CONTROL ANALYSES OF SOLUTIONS USED IN PARTIAL ACETYLATION OF COTTON. Buras, E. M., Jr.; Cooper, A. S.; and Cruz, M. D. U.S. Dept. Agr. ARS 72-11; 15 pp. 1958. (Processed.)

Information in this booklet is very similar to that presented in No. 1587, but more detail is included, and there are several additional tables.

1587. SIMPLIFIED CONTROL ANALYSES OF SOLUTIONS USED IN PARTIAL ACETYLATION OF COTTON. Buras, E. M., Jr.; Cooper, A. S.; and Cruz, M. D. Anal. Chem. *30:* 104–7. 1958.

Volumetric methods have been developed for the rapid analysis of acetic acid-acetic anhydride-perchloric acid and acetic acid-water-perchloric acid mixtures that occur in three-component baths during the practical partial acetylation of cotton. Perchloric acid is determined by titration in anhydrous acetic acid solution with standardized potassium biphthalate, using p-naphtholbenzein indicator. Water and acetic anhydride are determined empirically by phase separation in the presence of a large volume of hydrocarbon solvent. The methods are satisfactory as control methods in pilot-scale operations for the partial acetylation of cotton.

1421. NEW HORIZONS FOR CANVAS AWNINGS. Brysson, R. J.; Berard, W. N.; Bailey, J. V.; and DuPré, A. M., Jr. Canvas Prods. Rev. *32* (12): 36–37, 40–42. 1957.

Results are reported from investigations conducted in cooperation with Canvas Products Association International under a research project to improve the durability of cotton awnings. Base fabric treated with urea formaldehyde resin plus copper-8-quinolinolate showed excellent strength retention after weather exposure for 1 year. Base fabrics of cottons treated by cyanoethylation and by partial acetylation showed improved resistance to microbiological degradation. Heavy-duty sewing threads that were vat-dyed, partially acetylated, and glacéed had a strength retention of 76 percent after 1 year of outdoor exposure compared to 18 percent for conventional threads. Coating tests indicated that alkyd resins are superior to natural oil type coatings; inorganic pigments afforded better protection to the canvas than did organic types and had better color retention during exposure.

1511. VAPOR PHASE METHOD FOR PREPARATION OF POLYACRYLONITRILE COATED COTTON YARN AND PHYSICAL PROPERTIES OF THE PRODUCT. Haydel, C. H.; Janssen, H. J.; Seal, J. F.; Vix, H. L. E.; and Gastrock, E. A. Textile Research J. *27:* 975–82. 1957.

Acrylonitrile vapors were polymerized within and upon the individual fiber surfaces of scoured cotton yarns to yield coated products having new and interesting properties. The uniformity of the polyacrylonitrile coating is shown in electron micrographs of the fiber surfaces. Breaking strengths were increased appreciably, particularly when the process was applied to prestretched yarns. High frictional characteristics were exhibited when one coated yarn was pulled against another. Excellent resistance to rot and flat abrasion was obtained in conjunction with a relatively minor improvement in resistance to acid degradation. No essential change in heat and weather resistance was noted. Resistance to flexing, however, was adversely affected by the presence of the polyacrylonitrile. These polymer-coated yarns can be prepared with essentially the same equipment and procedures as those required for the vapor phase cyanoethylation of cotton; the only exception is that a different catalyst is employed. This illustrates the utility of acrylonitrile for preparation of a variety of useful cotton products.

1505. PHYSICAL PROPERTIES OF FIBERS AND YARNS OF PARTIALLY ACETYLATED COTTONS. Orr, R. S.; Weiss, L. C.; Burgis, A. W.; and Grant, J. N. Textile Research J. *27:* 966–75. 1957.

Samples of cotton of Deltapine, Rowden, and Stoneville varieties were partially acetylated as bulk cotton and as untreated 14/3 yarns to acetyl contents ranging from 9 to 26 percent. Breaking loads and elongations-at-break of single fibers, fiber bundles, and yarns were decreased by the partial acetylation up to about 17 percent but showed a tendency to increase above 20-percent acetyl content. Moisture conditions have less effect on tenacity of yarns of 25 percent than on those with lower acetyl content. Tenacities of the acetylated yarns when wet were slightly lower; when desiccator-dried, they were higher than those of the untreated controls. Below 15 percent, the relation of density to acetyl content was consistent with calculations based on the preferential reaction of amorphous cellulose in the initial stages of the reaction. Resistance to heat degradation increased with acetyl content up to 25-percent acetyl. The pH of the water used to rinse the reacted yarns was an important factor influencing heat degradation. Maximum retention of strength occurred when the wash water was in the pH range of 10 to 11. A slight but consistent difference in heat resistance of the partially acetylated cotton was associated with different varieties.

1494. EXPERIMENTAL YARNS FROM PARTIALLY ACETYLATED COTTON AND BLENDS WITH UNTREATED COTTON. Sloan, W. G.; Sens, C. L.; and Buras, E. M., Jr. Textile Research J. *27:* 796–802. 1957.

A number of experimental yarns were spun from partially acetylated (PA) cotton stock to determine some of the factors that improve its mechanical processing and yarn properties. These studies indicated that blending PA cotton stock with raw cotton was a better method of preparation for mechanical processing than was the use of an antistatic treatment on the PA stock. Blending resulted in better mechanical processing and improved yarn properties at a lower cost. Blending of high acetyl PA cotton with 40-percent raw cotton was considered to be the best method of preparation. PA stock prepared from a raingrown cotton exhibited better mechanical processing characteristics than did stock prepared from a longer staple, irrigated cotton. However, yarns spun from the latter type of PA cotton had better properties of strength, elongation, and flex-abrasion resistance. The use of a higher twist multiplier in spinning and plying resulted in PA cotton yarns having improved properties of elongation and flex-abrasion resistance.

1411. ACID AND ALKALI RESISTANCE OF PARTIALLY ACETYLATED COTTON FABRICS. Honold, Edith; Keating, E. J.; and Skau, E. L. Textile Research J. *27:* 400–11. 1957.

Investigations have been made of the acid and alkali resistance of partially acetylated cotton fabrics, and it has been found that property changes depend on both the original acetyl percentage and the degree of deacetylation effected by the acid solutions. The effect of hydrochloric acid was studied in greatest detail. High-acetyl fabrics are markedly more resistant to deacetylation than are those with low acetyl content. Break- and tear-strength protection against acid solutions increase with the degree of original acetylation. As severity of the acid treatment increases, elongation-at-break for acetylated fabric increases to a maximum before decreasing below that of the untreated fabric; while elongation-at-break for the unacetylated fabric decreases in proportion to the loss in breaking strength. Moisture sorption increases rapidly with deacetylation to a maximum value that is successively higher in the order of increasing original acetyl content. Moisture sorptions of the three most highly acetylated fabrics reached and maintained values above those of the unacetylated fabric. This finding suggests that the structure of the cotton is altered permanently by introduction of more than 15-percent acetyl. Heat resistance was as great at 11-percent acetyl as at 28 percent, but acid resistance is markedly greater at the higher acetyl percentages. Less detailed data are presented for other acid solutions and for a few alkaline solutions at two different temperatures.

1419. INFLUENCE OF PRETREATMENT ON THE REACTIVITY OF COTTON AS MEASURED BY ACETYLATION. Demint, R. J.; and Hoffpauir, C. L. Textile Research J. *27:* 290–94. 1957.

It is apparent from the data presented that differences in the structure of cotton textile can have a marked effect on the rate at which it reacts with acetic anhydride in the presence of perchloric acid. Little or no differences in reactivity were observed for the 1-in. cut sliver lap, the raw 34s/2 yarn, and the fabric. The bulkier 7s/3 yarn reacts at a somewhat faster rate, whereas the ground sliver shows a definitely lower reactivity than does the above group. Pretreatments such as scouring with low concentrations of sodium hydroxide and alcohol and water extraction were found to increase the reactivity of cotton. Decrystallization also increased the reactivity but not so much as scouring or extraction. However, when decrystallization is followed by solvent exchange of moisture with acetic acid without drying, the rate of acetylation is materially increased. There are indications that solvent exchange would also supplement the increased reactivity brought about by other pretreatments. Among the simplest and easiest methods of increasing the reactivity of cotton is a treatment with boiling water for a short period.

1423. A PRELIMINARY REPORT ON FULLY ACETYLATED COTTON. Buras, E. M., Jr.; Hobart, S. R.; Hamalainen, Carl; and Cooper, A. S., Jr. Textile Research J. *27:* 214–22. 1957.

A small-scale method is reported for preparing a completely, or almost completely, substituted cellulosic product known as fully acetylated (FA) cotton from cotton raw stock, yarn, or fabric by the application of acetic anhydride and perchloric acid catalyst in a diluent that minimizes the tendency of the product to dissolve. Its general properties and behavior in laboratory tests show it to have some properties in which it is superior to previously known cellulosic fibers, including partial acetates and triacetates. FA cotton has good tenacity, both wet and dry, and flex-abrasion endurance; it has some thermoplasticity, yet shows no sticking at ironing temperatures below 250° C.; and it has low moisture regain and is dyeable with ordinary acetate colors. Work in progress indicates that treatment of yarn and fabric may be carried out satisfactorily in commercial-type stainless steel equipment.

1424. PROTECTIVE TREATMENTS FOR COTTON AWNINGS. Brysson, R. J.; Berard, W. N.; and Bailey, J. V. Textile Research J. *27:* 209–13. 1957.

The cooperative research program of the Southern Utilization Research Branch and the National Canvas Goods Manufacturers' Association for improvement in the durability of cotton awnings and other outdoor fabrics is described, and results of the preliminary weathering-exposure studies performed under the joint program are presented. Data were obtained on a number of laboratory experimental and proprietary weather-resistant treatments for awning fabrics that had been exposed to outdoor weathering. Laboratory-prepared coatings and standard commercial coatings are compared after 12 months' weather exposure. Data are presented to demonstrate the increase in weather durability of heavy duty cotton sewing threads treated by the vat dyeing and acetylation process.

1429. **THE CELLULOSE-ALKALI HYDROXIDE-WATER SYSTEM IN THE CYANOETHYLATION OF COTTON CELLULOSE.** Klein, Elias; Weaver, J. W.; Webre, B. G.; and Jurgens, J. F. Textile Research J. *27:* 50–53. 1957.

When cotton cellulose is cyanoethylated with a large excess of acrylonitrile in the presence of aqueous alkali hydroxides at a fixed time and temperature, the rate of reaction is controlled by the ratios of base: cellulose: water. The variations in yield and rate of cyanoethylation can be explained by considering the changes brought about in cellulosate ion concentration, solubility of acrylonitrile, and bond strengths, by varying the amount, concentration, and nature of the alkali hydroxide on the cellulose. The microbiological resistance of the product is dependent on the same ratios because of the formation of carboxyl groups in the product; the rate of formation is governed by the strength and quantity of the aqueous base and the time of the reaction.

1418. **THE INFLUENCE OF MICRONAIRE FINENESS AND PRIOR TREATMENTS ON THE CYANOETHYLATION OF COTTON.** Reinhardt, R. M.; and Tallant, J. D. Textile Research J. *27:* 24–29. 1957.

Fiber fineness, as measured by the micronaire, and prior treatments have been found to be important factors in determining the rate and extent of cyanoethylation of cotton. Fineness was found to be a good index of the rate of reaction for both raw and pressure-boiled cotton fibers. Prior treatment of yarn by ethanol extraction, pressure boiling with 2-percent caustic, ethanolamine extraction, and mercerization, both slack and at constant length, affected the rate of cyanoethylation and the rot resistance of the product.

1431. **MICROSCOPICAL OBSERVATIONS ON PARTIALLY ACETYLATED COTTONS AND RELATED FIBERS.** Tripp, V. W.; Giuffria, Ruth; and deGruy, I. V. Textile Research J. *27:* 14–24. 1957.

Effects of acetylation on the morphology and submicroscopic structure of cotton have been studied by light and electron microscopy. The cross-sectional area of partially acetylated (PA) fibers increases with degree of substitution; the average refractive index decreases with increase in acetyl content, as to the indices measured parallel and perpendicular to the fiber axis. Refractive index measurement appears to be a feasible method for estimating the chemical composition of PA cotton. At early stages of esterification, unevenness of reaction along the length of fibers may be demonstrated by dyeing and swelling techniques. Acetylation causes the surface of cotton to become smoother and obliterates the microfibrillate pattern characteristic of scoured fibers. PA cotton fibers swell when embedded in methacrylic esters by polymerization. Separation of the lamellae of the secondary wall permits electron microscopical observations on the interior elements of the fiber to be made on thin cross sections of the specimen. The results of microscopical examination are considered in terms of fiber structure.

1446. **HYDROLYSIS OF ACETIC ANHYDRIDE IN CONCENTRATED ACETIC ACID WITHOUT CATALYSIS.** Janssen, H. J.; Haydel, C. H.; and Greathouse, L. H. Ind. Eng. Chem. *49:* 197–201. 1957.

The uncatalyzed hydrolysis of acetic anhydride in concentrated acetic acid solution has been followed by thermometric methods based on observations that the heat evolved during reaction, when catalyzed with perchloric acid, is an accurate measure of the quantities reacting. The initial reaction is followed by direct measurement of temperature rise, which had a negligible effect on the hydrolysis rate for the first hour. In the second procedure, aliquots from a reacting mixture held at constant temperature are analyzed by observing the temperature rise when perchloric acid is added. The reaction for the nearly equivalent concentrations of water and anhydride employed appears to be of the second order, with a rate coefficient of approximately 6.5 X 10^{-4} at 25° C. This agrees with literature values. The effect of the dicyandiamide treatment on cyanoethylated cotton, partially acetylated cotton, and aminized cotton, as well as on acetate and viscose rayon, is also discussed. The dicyandiamide finish is not stable if the fabric is washed in water.

1506. **SOLUBILITY OF ACRYLONITRILE IN AQUEOUS BASES AND ALKALI SALTS.** Klein, Elias; Weaver, J. W.; and Webre, B. G. Chem. & Eng. Data Ser. *2:* 72–75. 1957.

The solubility of acrylonitrile has been measured in various concentrations of lithium, sodium, and potassium hydroxides. The addition of hydrotropic salts, such as sodium iodide, sodium benzoate, sodium xylene sulfonate, and potassium iodide, increases the solubility of acrylonitrile in water and in aqueous base solutions. The hydrotropic effect of these salts in aqueous base solutions ceases at specific concentrations of the base; these concentrations are dependent on the nature of the hydrotropic salts and of the bases. In general, the greater the hydrotropic effect of the salt in water, the greater will be the range of base concentrations over which the effect will prevail.

1344. **CYANOETHYLATION OF COTTON FABRIC.** Greathouse, L. H.; Janssen, H. J.; Berard, W. N.; and Haydel, C. H. Ind. Eng. Chem. *48:* 1263–67. 1956.

A pilot-plant study was undertaken to determine the conditions affecting uniformity of treatment in the cyanoethylation of cotton yarns and fabrics. Results indicate that local overheating during the reaction is one of the principal causes of uneven treatment. By careful control of reaction conditions, 45-yard lengths of standard print cloth were cyanoethylated within limits of 0.40 to 0.42 cyanoethyl addition per anhydroglucose unit. This evenness of modification existed even between single yarns and fibers and along the length of individual fibers. Special pilot-plant equipment adapted to provide the required conditions is described.

1356. **PARTIALLY ACETYLATED COTTON FIBER AND TREATMENTS TO FACILITATE PROCESSING INTO YARN.** Sloan, W. G.; Buras, E. M., Jr.; Goldthwait, C. F.; and Murphy, A. L. Am. Dyestuff Reptr. *45:* 429–33. 1956.

A study has been made of partially acetylated cotton stock and treatments applied to facilitate processing into yarn. Changes in physical properties of the fiber upon acetylation are discussed, and difficulties encountered in mechanical processing are described. The investigation of possible methods of overcoming these difficulties, both by the application of antistatic finishes and by spinning blends of small amounts of raw cotton with acetylated cotton, is described. Data are given on strength and heat endurance of yarns spun from small lots of acetylated stock, and effects of both the antistatic treatment and the blending on these properties are shown.

1295. **THERMOMETRIC DETERMINATIONS OF WATER AND ACETIC ANHYDRIDE IN ACETIC ACID.** Greathouse, L. H.; Janssen, H. J.; and Haydel, C. H. Anal. Chem. *28:* 357–61. 1956.

The temperature rise occurring during the exothermic reaction of water and acetic anhydride in glacial acetic acid solution, catalyzed by a trace of perchloric acid, is employed to determine the concentration of either of these reactants in the presence of an excess of the other. Two different techniques are described. In one, the reaction is conducted in a Dewar flask. The temperature rise that takes place is a direct measure of the component being determined. By the other procedure, either water or the anhydride is titrated in glacial acetic acid solution with a standard solution of the other until no further temperature rise occurs. Either procedure is conducted with adequate protection from atmospheric moisture. A qualitative method is described to detect the presence of water, acetic anhydride, or perchloric acid, within limits, in glacial acetic acid solution.

1355. NEW TEXTILE PRODUCTS FROM COTTON—PARTIALLY ACETYLATED COTTON. Buras, E. M., Jr.; and Persell, R. M. U.S. Dept. Agr. ARS 72-4, 24 pp. 1956. (Processed.)

This brochure summarizes information in PA (partially acetylated) cotton. Topics include: Fibrous cellulose derivatives from cotton; chemical nature of PA cotton; properties, present and potential uses, availability, and estimated costs of PA cotton. Information on additional textile products from cotton and cotton as a raw material for the chemical industry is summarized, and a bibliography of 22 titles is included.

1347. EFFECT OF ALKALINE HYDROLYSIS ON THE PROPERTIES OF CYANOETHYLATED COTTON. Mazzeno, L. W., Jr.; Reinhardt, R. M.; Reid, J. D.; and Dickson, J. B. Textile Research J. *26:* 598–606. 1956.

Cyanoethylated cotton has been subjected to treatment with excess 1-percent aqueous sodium hydroxide at temperatures of 22°, 60°, and 97° C. Rates of cleavage of cyanoethyl groups at these temperatures have been determined. Resistance to rotting is destroyed by removing part of the cyanoethyl groups. Heat resistance is decreased by the alkaline treatment but only to the extent that nitrogen is removed. It appears that heat resistance is directly proportional to the nitrogen content regardless of the previous history of the sample. Dyeing characteristics, measured by a differential staining technique, show reversion to the color of untreated cotton even though only half the nitrogen is removed. Physical properties are not adversely affected by alkaline hydrolysis. Tenacity increases as groups are cleaved but does not return to the original value of the gray yarn. This is the usual case with other cellulose derivatives. The knot-strength data do not indicate brittleness. Hydrolysis has little effect on elongation.

1342. THE CELLULOSE-SODIUM HYDROXIDE-WATER SYSTEM IN THE CYANOETHYLATION OF COTTON CELLULOSE. Weaver, J. W.; Klein, Elias; Webre, B. G.; and DuPré, E. F. Textile Research J. *26:* 518–23. 1956.

When cotton is cyanoethylated with a large excess of acrylonitrile in the presence of aqueous alkali at fixed time and temperature, the extent of cyanoethylation and byproduct formation is controlled by the ratios of cellulose, sodium hydroxide, and water employed. The mechanical restraints offered by the yarn and fabric structures alter these optimum conditions as well as the extent of cyanoethylation that takes place. Cyanoethylated cottons having essentially equal nitrogen contents but different properties can be prepared from a large number of compositions of cellulose, sodium hydroxide, and water. High sodium hydroxide contents in the starting mixtures result in substantial conversion to carboxyethyl groups with a subsequent loss of resistance to microbiological attack.

1265. THE EFFECT OF LAUNDERING, MERCERIZING AND SIMULATED VAT DYEING ON THE PROPERTIES OF PARTIALLY CYANOETHYLATED COTTON. Reinhardt, R. M.; Markezich, A. R.; Moore, H. B.; and Reid, J. D. Textile Research J. *26:* 423–29. 1956.

Cotton sheeting cyanoethylated to various nitrogen contents from 2.2 to 6.4 percent was subjected to laundering, mercerizing, or simulated vat dyeing. The samples were then analyzed for thread count, weight, and thickness and tested for breaking strength, elongation, tearing strength, abrasion resistance, air permeability, stiffness, moisture regain, heat resistance, and rot resistance. In addition, wrinkle recovery of the partially cyanoethylated and untreated cloth was determined. Results indicate that laundering, mercerizing, and simulated vat dyeing do not seriously affect the usual textile properties of partially cyanoethylated cotton. The rot resistance and heat resistance of samples of more than 4-percent nitrogen content were not greatly impaired by these treatments; however, a sample of 3.2 percent N was not rot-resistant after these subsequent treatments.

1268. INFLUENCE OF MOISTURE SORPTION AND OTHER PRETREATMENTS ON THE ACETYLATION OF COTTON WITH ACETIC ANHYDRIDE AND PYRIDINE. Blouin, F. A.; Reeves, R. E.; and Hoffpauir, C. L. Textile Research J. *26:* 272–75. 1956.

A study of the acetic anhydride-pyridine procedure for acetylation of cotton has shown that the degree of acetylation under specified conditions is not only dependent on the moisture content but also on the previous moisture sorption history of the sample. The data indicate that under the conditions employed, reactivity is greater in cotton fibers desorbing moisture than in those of equal moisture content that are absorbing moisture. This effect can be obscured by long pretreatment with pyridine. Increased reactivity similar to that produced by moisture can be obtained by using a number of other pretreatments. However, the degree of reactivity produced by high moisture contents could be exceeded only by pretreating agents generally considered to penetrate the crystalline regions of the cotton. It was also found that the increased reactivity produced by treatment with strong alkali was not completely lost on drying.

1266. THE EFFECT OF PARTIAL ACETYLATION ON THE PORE-SIZE DISTRIBUTION OF COTTON FABRICS. Honold, Edith; Boucher, R. E.; and Skau, E. L. Textile Research J. *26:* 263–71. 1956.

Partial acetylation increases the weight and decreases the density of a cotton fiber; and, as acetylation increases, the coarseness of the fiber increases rapidly. When acetylation is carried out on either yarns or fabrics, the geometric structure of the sample changes so that the yarns become tighter and the fabrics denser according to the restriction placed on the enlarged fibers. In order to gain some insight into the structural modification of a fabric after partial acetylation, the pore-size distributions of the void volumes within the fabric boundaries were determined on a cotton-sheeting series whose acetyl content ranged from 0 to 28.2 percent. As the acetyl content of the sheeting samples increased, there was a general downward trend in total void volume within the interfiber region. For comparison, this study included two additional fabrics whose constructions were as nearly alike as possible and whose yarns had been spun, respectively, from Iquitos cotton and from Iquitos fibers after partial acetylation in the fiber form to 17.4-percent acetyl. The peak shift from the unacetylated to the acetylated was in the same direction and of the same order of magnitude as that for the two comparable members of the sheeting series.

1267. IMPROVED WEATHER RESISTANCE BY ACETYLATING VAT-DYED COTTON. Berard, W. N.; Gremillion, S. G., Jr.; and Goldthwait, C. F. Textile Research J. *26:* 81–86. 1956.

Cotton has been made unusually resistant to degradation by weather by first dyeing it with certain light-stable vat dyes and following this with partial acetylation. Vat dyeing alone or partial acetylation alone does not make cotton significantly more resistant to deterioration by sunlight than undyed fabrics, except for a few colors that do have a protective effect. However, when these two processes are combined, excellent resistance to solar radiation is added to the excellent mildew- and rot-resistance of partially acetylated cotton. Data were obtained on a number of individual vat-dyed and vat-dyed and acetylated cotton materials that had been exposed to outdoor weathering. From the results of these tests, it is estimated that cotton vat dyed with light-fast colors and acetylated may give more than twice the outdoor service life that cotton vat dyed only or acetylated only will give; and it also has somewhat better color retention.

1195. DETERMINATION OF BETA, BETA'-OXYDIPROPIONITRILE AND ETHYLENE CYANOHYDRIN WITH ACRYLONITRILE BY INFRARED ABSORPTION. DuPré, E. F.; Armstrong, A. C.; Klein, Elias; and O'Connor, R. T. Anal. Chem. *27:* 1878–79. 1955.

This paper presents an analytical method for determining beta, beta'-oxydipropionitrile, and ethylene cyanohydrin in admixture with acrylonitrile. In several reactions involving acrylonitrile, the efficiency is decreased by the formation of byproducts, among which are beta, beta'-oxydipropionitrile, and ethylene cyanohydrin. Studies of the effect of catalyst, temperature, etc., on reducing the formation of these undesirable byproducts require a method for their analysis in admixture with acrylonitrile. A simple multicomponent analysis by means of infrared absorption spectra is described that permits a simultaneous determination of the three compounds.

1132. PREPARATION OF PARTIALLY CYANOETHYLATED COTTON WITH ACRYLONITRILE. Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. Textile Research J. *25:* 246–53. 1955.

The preparation of partially cyanoethylated cotton with acrylonitrile in the presence of sodium hydroxide is described, including effects of changes in time, temperature, and concentration of reagents. Products with retention of the fibrous form have been obtained with degrees of substitution up to 2.7 cyanoethyl groups per anhydroglucose unit. Hydrolysis of the cyanoethyl group occurs readily under alkaline conditions and results in both cleavage and conversion to the carboxyethyl group. Maximum conversion in the latter case was 29 percent.

1133. PROGRESS REPORT ON CYANOETHYLATED COTTON. Grant, J. N.; Greathouse, L. H.; Reid, J. D.; and Weaver, J. W. Textile Research J. *25:* 76–83. 1955.

The mechanism of cyanoethylation of cotton is discussed, and it is shown that for best efficiency the pickup of sodium hydroxide must not exceed 15 percent of the weight of the cotton. Increases in the breaking strength or elongation of yarns are results of changes in frictional forces. Physical properties of cyanoethylated fabrics reflect the properties of the yarn and are also dependent on fabric construction. Extremely high resistance to flat abrasion is obtained with high cyanoethyl substitution. The density of cyanoethylated cotton is shown to be linearly related to nitrogen content, and the spread of values is shown to give an estimate of uniformity of treatment. Cyanoethylated cotton can be dyed by methods developed for polyacrylonitrile fibers such as those employing acid dyes in the presence of cuprous ion, and the dyed samples so produced are suitable for cross sectioning for microscopic examination. The intensity of dye color can be used as a measure of the amount of cyanoethylation.

1200. PARTIAL ACETYLATION OF PAPER FOR CHROMATOGRAPHY. Buras, E. M., Jr.; and Hobart, S. R. Anal. Chem. *27:* 1507–8. 1955.

Reference is made to the use of paper that is less hydrophilic than ordinary filter paper in specialized applications of paper chromatography. Acetylated filter paper has been used as the carrier for the stationary phase in some chromatographic separation procedures. This paper describes a relatively rapid laboratory method for partial acetylation of filter paper to give a strong, white product.

1080. THE DYEING OF CYANOETHYLATED COTTON. Schuyten, H. A.; and Weaver, J. W. Textile Research J. *24:* 1005. 1954.

Methods employed in the dyeing of polyacrylonitrile fibers can be applied to cyanoethylated cotton of low substitution; and basic dyes that do not ordinarily dye cotton will dye cyanoethylated cotton. Acid dyes discolor untreated cotton only slightly; but, when cyanoethyl groups are present, absorption of the dye is increased to produce an extremely light shade. The dyes are absorbed to only a negligible extent by cyanoethylated cotton with substitutions as high as 1 cyanoethyl group per anhydroglucose unit (6.5 percent N).

1079. RESISTANCE OF PARTIALLY ACETYLATED COTTON FABRIC TO NITROGEN DIOXIDE AND TO HYDROGEN CHLORIDE. Schrieber, W. T.; Bullock, A. L.; and Ward, W. L. Textile Research J. *24:* 819–22. 1954.

The resistance of partially acetylated cotton to the tendering action of nitrogen dioxide is of interest because of the possible use of partially acetylated cotton filters for removing dusts from fume-laden air or for other purposes where resistance to oxidizing agents or to acids is required. A possible explanation of the protective effect of partial acetylation is that, by substituting acetyl groups for the more accessible of the hydroxyl groups, these larger groups interfere with access of the gas to vulnerable groupings in the cellulose molecule. The protective action of acetylation against breaking of the cellulose chains is probably due to blocking of hydrolysis of the glucosidic linkages.

1078.1. THE EFFECT OF TIME AND TEMPERATURE OF PRESOAKING AND THE TEMPERATURE OF ACETYLATION ON THE RATE AND DEGREE OF ACETYLATION OF COTTON FIBERS. Taylor, J. L.; and Owens, E. D. Textile Research J. *24:* 810–19. 1954.

In a study of the effects of time and temperature of presoaking on the rate of acetylation of cotton fibers, it was found that, as the temperature of the glacial acetic acid used for presoaking increased, the degree of acetylation increased rapidly, particularly for the shorter presoaking periods. As the presoaking time increased, however, the temperature had less effect in most cases. Six varieties of cotton were used in the investigations. The order of maximum acetyl content under the same acetylating conditions obtained for the various fibers was Memphis, Acala 1517, Stoneville 2B, Empire Bale, Bob Shaw, and Lockett 140. In general, it was found also that the more mature the fiber, the less the degree of acetylation under constant conditions. The higher temperatures of acetylation produced greater degrees of acetylation, and the fibers also suffered greater degradation. An increase from 58° to 82° F. approximately doubled the acetyl content obtained; weakening was so great that fiber strengths were unobtainable at 82°.

984. **DEGRADATION OF COTTON FIBERS AND YARNS BY HEAT AND MOISTURE.** Orr, R. S.; Weiss, L. C.; Humphreys, G. C.; Mares, T.; and Grant, J. N. Textile Research J. *24:* 399–406. 1954.

Strength and elongation of cotton fibers were correlated with yarn properties after heating the fibers and yarns from 2 to 128 hours in an oven at 110°, 138°, and 162° C. in air representing relative humidities from 3 percent up to saturation. Losses in yarn and fiber strengths are closely related; fiber and yarn strength and elongation are reduced by heat at the higher temperatures, regardless of the moisture present. But for the least amount of degradation, moisture should be either very low or high enough to exclude air (at saturation point). A simultaneous reduction of strength and elongation of fibers indicate that degradation occurs through creating or intensifying weak points along the fiber—an indication confirmed through viscosity determinations.

996. **PRACTICAL PARTIAL ACETYLATION OF COTTON.** Buras, E. M., Jr.; Cooper, A. S.; Keating, E. J.; and Goldthwait, C. F. Am. Dyestuff Reptr. *43:* 203–8. 1954.

Practical processes for the partial acetylation of cotton, well adapted for commercial use, have been worked out. The process converts cotton into a new type of textile fiber with several new or improved properties. Several commercial developments are based on these processes. Fabric can be acetylated on stainless steel dye jigs, such as those used in cotton finishing plants, or on a newly developed continuous range; yarns, in package form or continuously as warp; raw stock, in a raw-stock dyeing machine. The processes employ acetic acid and anhydride, with small amounts of perchloric acid as catalyst. Data on the concentration of chemicals used, duration of treatments, temperature, and other conditions required for best results have been determined.

702. **HEAT-RESISTANCE OF PARTIALLY ACETYLATED COTTON FABRICS.** Honold, Edith; Poynot, Janice; and Cucullu, A. F. Textile Research J. *22:* 25–29. 1952.

Specimens of commercial sheeting—unacetylated and acetylated (17.4-, 23.4-, and 28.7-percent acetyl)—were heated at 160° C. (320° F.) for varying periods of time in dry, oxygen-free nitrogen, in dry air, in water vapor, and in a mixture of water vapor and air. In nitrogen, the loss of breaking strength by acetylated fabrics was less than 3 percent; in air it was 4 to 7 percent; in water vapor, 4 to 8 percent; and in air and water vapor mixture, 8 to 16 percent. The losses for the unacetylated controls were 24 percent, 46 percent, 82 percent, and 83 percent, respectively. Losses in elongation-at-break tended to parallel losses in breaking strength. No measurable quantity of acetyl was lost from the acetylated fabrics during heating. After heating and reconditioning, all the fabrics showed a slight decrease in weight and in percentage of moisture regain, and a slight increase in thickness.

713. **PARTIAL ACETYLATION OF COTTON.** Cooper, A. S.; Voorhies, S. T., Jr.; Buras, E. M., Jr.; and Goldthwait, C. F. Textile Ind. *116* (1): 97–102, 194–95. 1952.

Processes are described for partially acetylating a yard or two of cotton cloth at a time, or small amounts of raw stock or loose yarn on a laboratory apparatus; for treating 50-pound lots of raw stock in a small stainless steel kier, and treating singles and other low-twist yarns, thread, twine, cord, net, and raw stock on a 6-pound dyeing machine; and for treating fabric on a dye jig. A dyeing test is used to determine qualitatively the uniformity of the treatment within a sample of any desired size. The cost of acetylating is probably, on a weight basis, about half the cost of the average gray goods.

798. **EFFECTS OF UNFILTERED CARBON ARC LIGHT IN ACCELERATED WEATHERING OF COTTON AND OTHER TEXTILES.** Dean, J. D.; Fleming, C. M.; and O'Connor, R. T. Textile Research J. *22:* 609–16. 1952.

The degradative effects produced in cotton and other fibers by unfiltered light from a "sunshine" type carbon arc lamp were compared with those that occurred in identical materials during natural weather exposure in which sunlight is believed to be the chief degrading factor. The comparative tests were designed to afford needed information about the action of short-wave radiation on textiles, and to evaluate the practical utility of such radiation in accelerated weathering techniques.

569. **EFFECT OF LIGHT ON COTTON TEXTILES.** Fynn, P. J.; and Dean, J. D. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 436–40.

Light acting on cotton textiles produces changes in the fundamental chemical structure that affect their strength and usefulness. Many scientific techniques are being employed in studies of these changes to obtain information that will be of use in making cotton more resistant to the deleterious action of light. Experimental finishes that have only slight effect on the appearance and feel of the fabrics in contrast to the stiff, boardlike nature of the commonly used protective treatments, are being tried with considerable success. Encouraging results are also being obtained from efforts to reduce the testing of such experimental finishes to a rapid laboratory procedure for use in place of the time-consuming weather-exposure method.

629. **CHEMICAL SUBSTITUTION IN FIBROUS COTTON AND RESISTANCE OF SUBSTITUTED COTTON TO MICROBIOLOGICAL DETERIORATION.** Goldthwait, C. F.; Buras, E. M., Jr., and Cooper, A. S. Textile Research J. *21:* 831–40. 1951.

The resistance for months to deterioration by microorganisms (in soil burial) of suitable acetylated fibrous cottons, some with only one-third of the hydroxyl groups substituted, depends on the distribution, as well as on the total number of the acetyl groups present. At one-third substitution, the amorphous cellulose is converted to triacetate; the cotton fiber still contains about two-thirds of the original cellulose, which is present as crystalline material surrounded by acetylated cellulose. The swelling capacity of the cotton in water is greatly reduced. Attacks by micro-organisms apparently begin at the most readily accessible amorphous cellulose. Protection by partial acetylation is believed to be due to the blocking of hydroxyl groups, the filling of spaces between chains in the amorphous cellulose, and the suppression of swelling.

531. **CORRELATION STUDIES OF ACCELERATED AND NATURAL WEATHERING TESTS OF PROTECTIVELY FINISHED COTTON DUCK.** Fynn, P. J.; Daly, C. N.; Fleming, C. M.; and Dean, J. D. Textile Research J. *21:* 116–23. 1951.

Accelerated and natural weather-exposure tests were made with unfinished cotton duck samples and with samples treated with mineral pigments, film-forming resins, and vat dyes, alone and in combinations. The finishes were ranked in order of excellence on the basis of amounts of original strength retained by individual samples in both types of exposure. Although statistical interpretation of the data obtained in the two types of tests indicated a positive correlation between them, the relationship was not sufficiently constant to justify reliance on the employed accelerated techniques in predicting the behavior of finished cotton textiles in outdoor service conditions.

570. **ACETYLATION TO MAKE A NEW TEXTILE.** Goldthwait, C. F. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 421–26.

The processes used at the Southern Regional Research Laboratory to produce partially acetylated cotton, cellulose acetate, or cotton in which some of the hydroxyl groups have been replaced by acetyl groups, are described in detail. The improved properties, including mainly the better rot resistance of the virtually new cotton product, are discussed. For example, partially acetylated cotton bags of the type used in household water-softening systems last several times as long as do untreated bags.

475. **EFFECT OF WEATHER ON BLEACHED AND UNBLEACHED COTTON DUCK.** Dean, J. D.; Berard, W. N.; and Worner, R. K. Textile Research J. *20:* 643–49. 1950.

Six replicate sets of bleached and unbleached (gray) samples of cotton duck, placed outside at 2-month intervals from December through October, were exposed for 1 year in New Orleans. Results showed that the gray cloth varied more in breaking strength but that fluidity variations in both types of cloth were similar. The average copper number of both gray and bleached fabrics increased fairly uniformly; that of the bleached fabrics after the first 2 months remained consistently higher. For gray and bleached cloth, copper number-fluidity relationships were practically linear.

381. **PARTIAL ACETYLATION OF COTTON CELLULOSE BY KETENE.** Hamalainen, Carl; and Reid, J. D. Ind. Eng. Chem. *41:* 1018–21. 1949.

Linters and cotton sewing thread have been acetylated with ketene. Treatment involves preswelling with water, removal of excess water by extraction, suspension of the cotton in an inert solvent containing a catalyst, and treatment with ketene as prepared by pyrolysis of acetone. Samples containing up to 17 percent of acetyl retained their fibrous structure with only slight degradation. The ketene acetylation was accompanied by an objectionable polymerization of ketene that produced a yellow to dark-brown coloration of the sample. The color could be removed by hot alcohol. Although the emphasis was on the reaction of water-activated, solvent-dehydrated cellulose with ketene, some experiments were tried in which the cotton was swollen with acetic acid before the introduction of the ketene. The acetylation was probably due to the acetic anhydride formed.

338. **RETARDATION OF HEAT-INDUCED STRENGTH LOSS IN COTTON YARNS BY LIQUID AMMONIA TREATMENT.** Moore, H. B. Textile Research J. *18:* 749–55. 1948.

In studies to determine the effect of various chemical treatments on improving the heat-resistance of cotton yarns and rovings, liquid ammonia gave promising results. Therefore, experiments were undertaken to determine the conditions under which treatment with ammonia produced the maximum retention of strength after prolonged periods of heating. The tests are described in detail, and findings are illustrated by charts and photomicrographs. The greater strength retention of treated yarns is believed to result from some frictional force operating between the constituent fibers under the conditions of the test, rather than to an increase in the strength of individual fibers.

331. **PRESERVING COTTON FABRICS IN OUTDOOR USE.** Dean, J. D. U.S. Dept. Agr. Cir. 790, 17 pp. 1948. (Processed.)

Woven cotton fabrics ranging from heavy duck to light shade cloth find many uses on the farm or ranch for such purposes as tents and awnings, coverings for machines, sacked grain and stacks, covers for horses, and shade for young plants. This circular tells how to select and care for these materials and describes simple methods of waterproofing and weatherproofing to prolong their serviceability. Formulas for some of the treatments are given.

335. **CELLULOSE BEHAVIOR WITH FILTERED SUNLIGHT.** Fynn, P. J.; Sands, J. E.; and Campbell, K. S. Textile Research J. *18:* 350–57. 1948.

Samples of kier-boiled cotton sheeting exposed to sunlight in a specially constructed cabinet designed to segregate sunlight from other factors and to keep the cloth flat and perpendicular to the sun, were compared with similar samples exposed on open racks facing the sun at various angles. Data obtained indicated that sunlight accounts for practically all the degrading effects on cotton fabrics by prolonged weather exposure, except where pronounced microbiological action or damage obviously due to corrosive atmospheric contaminants is present. While the results of this study also corroborated the accepted view that short wavelength radiations in sunlight cause the greatest damage, the degrading effect was not limited to these rays; and some antagonism between energies from different portions of the spectrum was indicated.

267. **WEATHER PROTECTIVE TREATMENTS FOR COTTON DUCK.** Dean, J. D.; Fynn, P. J., and other members of a committee from the Southeastern Section, American Association of Textile Chemists and Colorists. Am. Dyestuff Reptr. *36:* 705–10. 1947.

Four types of experimental formulations were tested by exposure to total weather at four geographical locations, exposure to sunlight alone, and exposure under carbon-arc radiation: (1) Clear resins alone; (2) resin-bound pigments; (3) pigments precipitated *in situ;* and (4) pigments *in situ* aftertreated with the clear resins. Urea-formaldehyde used alone had weather-protective properties and was even more effective when combined with pigments. Certain pigments applied *in situ* and pigments bound with oil-modified alkyd resin also effected a high degree of weather resistance. Treatments on samples exposed in a normal incidence cabinet to sunlight alone were rated in the same order of effectiveness as those on samples exposed outdoors, except for the gray control sample, which was degraded more than the bleached control. While carbon-arc exposures did not reveal a definite correlation with outdoor exposures, they indicated that a weathering machine can aid in classifying the ultraviolet light-screening properties of experimental treatments.

235. **AUTOMATIC, NORMAL-INCIDENCE SOLAR EXPOSURE CABINET.** Fynn, P. J.; and Campbell, K. S. Textile Research J. *17:* 158–66. 1947.

Special apparatus designed to measure the effect of solar radiation alone in the weathering of cotton fabrics and to provide a means of studying the action of different regions of the sun's spectrum is described and illustrated. The samples are exposed in a weatherproof, airtight, but unsealed cabinet, covered by a top containing six windows, each made from a different kind of glass color filter. A measure of control over the temperature, humidity, and circulation of air inside the cabinet is maintained. An automatic system of controls maintains the cabinet at normal incidence by continuously rotating it to face the sun throughout the day, and automatically records the total solar energy received, as well as the amount transmitted by the various filters. The apparatus has proved adequate under all the climatic conditions so far encountered.

266. **THE DEGRADATION OF UNTREATED COTTON FABRICS EXPOSED TO WEATHER IN A SUBTROPICAL CLIMATE.** Dean, J. D.; and Worner, R. K. Am. Dyestuff Reptr. *36:* 405–10, 423–24. 1947.

With the object of establishing year-round degradation patterns to aid in interpreting the performance of chemically treated fabrics exposed to weather in any season, replicate samples of selected fabrics were exposed to weather at spaced intervals of 2 months throughout the year, but under different seasonal conditions; and the degradation data secured were averaged. Changes in breaking strength and in cuprammonium fluidity were the chief criteria of degradation. Different degradation patterns resulted from the effects of weather on gray and on commercially purified cloth. Large breaking-strength losses in gray cloth attended by relatively slight increases in fluidity were attributed largely to biological action, since this type of degradation is not accompanied by concurrent fluidity increases. The slightly greater average strength losses in commercially purified fabrics, accompanied by relatively high fluidity values, were believed to be chiefly attributable to the photochemical action of sunlight.

184. **ACETYLATED COTTON HIGHLY RESISTANT TO ROTTING.** Goldthwait, C. F.; McLaren, James; and Voorhies, S. T., Jr. Textile World *96:* 115–17, 212, 216. 1946.

Partial acetylation of cotton cellulose in the form of fiber, yarn, thread, or cloth can be so conducted that the cotton retains its outward appearance but is highly mildew- and rot-resistant; is more resistant to heat than is ordinary cotton; has a lower moisture regain; and dyes similarly to acetate rayon. The partial acetylation was performed in various ways: For example, yarn and thread were treated in a stainless-steel package yarn-dyeing machine; while for cloth, a series of laboratory-size padders, aging chambers, and washers were used. Successful acetylations up to 30-percent acetyl content are reported. Processing cost is discussed and various uses are suggested. Rotting and outdoor exposure tests reported indicate the high degree of resistance to microbial attack imparted by the treatment.

209. **SERVICE TEST OF COPPER-TREATED COTTON SANDBAGS.** Dean, J. D.; Strickland, W. B.; and Berard, W. N. Am. Dyestuff Reptr. *35:* 346–48. 1946.

To establish the rotproofing effectiveness of various compounds, sandbags made from gray 7-ounce cotton Osnaburg were impregnated with eight copper compounds. Copper deposits were 1 percent on the weight of dry cotton using copper napthenate, copper ammonium fluoride, copper oleate, copper resinate, and copper tallate. Cuprammonium carbonate was used at the rate of 1.5-percent copper. In addition, 1-percent copper was deposited as naphthenate with 15-percent creosote, and 1.5-percent copper as cuprammonium carbonate with 50-percent creosote. Results of tests are tabulated by setting the fungicidal effect of copper napthenate at 100. Presence of creosote increased the rotproofing effect of copper napthenate to 176 and that of cuprammonium carbonate to 173. Cuprammonium carbonate had an index of 100; the resinate, an index of 45; and the untreated fabrics, an index of 9.

126. **THE SOIL BURIAL TEST FOR ROTPROOFED COTTON FABRICS.** Dean, J. D.; Strickland, W. B.; and Berard, W. N. Am. Dyestuff Reptr. *34:* 195–201. 1945.

A standardized soil-burial method of evaluating the rot resistance of treated cotton fabrics is described. Temperature and moisture conditions are closely controlled, and fresh soil must be used for each test if repeatable results are to be obtained. The test is of the long-range evaluation type and furnishes a reliable prediction of service performance for fabrics treated with a number of different rotproofing agents. The soil-burial resistance for copper napthenate-treated cotton Osnaburg was measured for 10 identical tests and found to be repeatable with a coefficient of variation of 8.5 percent.

30. **DETERMINATION OF COPPER IN TEXTILE MATERIALS TREATED TO PREVENT MILDEW.** Hoffpauir, C. L.; and O'Connor, R. T. Am. Dyestuff Reptr. *31:* 395–98. 1942.

Two well-known methods for the determination of copper have been adapted to analysis of "mildew-proofed" fabrics. The values obtained by these methods are in good agreement. Preparation of the copper solution is the same in both methods except for the final step. Actual measure of the copper in the solution consumes only a small portion of the total time required for the determination. The volumetric method has proved satisfactory for routine examination of samples of ordinary size containing moderate amounts of copper. It is rapid and accurate and requires only ordinary analytical apparatus. The spectrophotometric method gives an excellent check on the volumetric method and is particularly useful when the sample is small or if the percentage of copper is relatively low. It has the disadvantage of requiring special apparatus.

Mercerization and Luster

1788. **STUDY OF IMPROVEMENT OF SMOOTHNESS OF COTTON FABRICS.** Goldthwait, C. F.; Kirby, R. D.; Fretwell, Sam; and Wiehart, Hans. Textile Research J. *29:* 134–43. 1959.

Exploratory research has sought the most promising ways of imparting a high degree of durable smoothness to cotton cloth. This work, limited to laboratory procedures, has resulted in finishes characterized by different degrees of smoothness, of luster or glaze, and of durability. Smoothness was very well retained in the best of these finishes and can be considered permanent, although luster decreased gradually on washing. Some of these finishes seem readily adaptable to lining and other apparel fabrics. The work was based on the use of an experimental calender and largely on the calendering of cloth while it was wet in a state of swelling greater than that from mere wetting with water. There would be difficulties in practical operation if the water in the cloth contained dissolved finishing agents or if the cloth was too wet. Objections have been partially met by preswelling, washing, padding the wet cloth in a softening and fixing agent, and then drying before calendering. Promising for further investigation is close control of moisture content of the cloth at the time of calendering, at levels between those of present practice and values attained in this research. A range of 15- to 40-percent regain in cottons treated as described, but only partially dried before calendering, is suggested. Higher calender temperatures and pressures should also be considered.

1562. **COMPARATIVE MERCERIZATION OF YARNS MADE FROM PIMA S-1, PERUVIAN PIMA B-B, AND EGYPTIAN KARNAK COTTONS.** Murphy, A. L.; and Goldthwait, C. F. Textile Research J. *28:* 267–69. 1958.

The mercerizing characteristics of yarn made from lots of Pima S-1, Peruvian Pima, and Egyptian Karnak cottons have been compared. The yarns were mercerized in several different ways to compare them under these different conditions, but very little difference was found among the cottons. These tests were part of an extensive study of methods for evaluating the mercerizing characteristics of cottons of different varieties or growths, which are of interest to both breeder and user of cottons. The comparisons made here are reported because of particular immediate interest by users of these cottons.

1572. **IMPROVED LIGHT AND WEATHER RESISTANCE OF COTTON RESULTING FROM MERCERIZATION.** Goldthwait, C. F.; and Robinson, H. M. Textile Research J. *28:* 120–26. 1958.

Comparative exposures of mercerized and unmercerized cotton to light and to weathering brought out anomalous effects in the breakdown of cotton cellulose. There was less deterioration of the mercerized cotton, as measured by the ability of the fabric to resist rupture by tension (measured by breaking strength), but more degradation (as determined by fluidity measurements), indicating a reduction in average degree of polymerization of the cellulose. These observations are consistent with reports in the literature that mercerized cotton is somewhat more susceptible to oxidation and to hydrolysis than is comparable unmercerized cotton. The behavior in exposure to light evidently is part of a general phenomenon, because higher fluidities have been observed for the chemically reactive mercerized cottons under conditions where the strength losses for mercerized and unmercerized cottons were equal. The higher retention of strength by the mercerized cotton may represent a significant advantage, because it promises a longer service life of mercerized goods when deterioration occurs mainly from exposure to sunlight. When ordinary unmercerized cotton has lost half strength, corresponding mercerized cotton can be expected to last for one-quarter to one-third longer before reaching that level.

1578. **NOVEL MERCERIZING TECHNIQUE TO ESTABLISH "TRUE" LENGTH OF COTTON YARN.** Goldthwait, C. F.; and Murphy, A. L. Textile Research J. *28:* 15–21. 1958. Republished, Textile J. of Australia *33* (2): 216, 218, 252–55. 1958.

A procedure is suggested for determining the length at which the yarn in a skein can be regarded as straightened but not stretched. This procedure requires the determination of the tensions developed in a series of mercerizings of skeins of yarn that are alike but are set in the mercerizing apparatus at lengths that differ by small percentages. When the maximum tensions attained are suitably plotted, a change in slope in the curve indicates a point that corresponds with the desired length. A unit measuring-tension for the precise measurement of skeins of yarn which are, for example, to be used subsequently for chemical treatment, can then be derived. More specifically, a suitable tension for measuring has been found to be 1.2 pounds per lea of 120 yards of 40/2 yarn of mercerizing twist. Equivalent tensions can be calculated readily for other sizes of skein and for many other yarns. The change in slope appears, further, to pinpoint a fundamental change in the response of cotton yarn under increasing tension just as it begins to stretch. It is suggested also that a measuring-tension for single threads derived from results with skeins may be suitable for determining the initial lengths of yarns for some of the common physical tests such as those for elongation and twist.

1140. **IMPROVEMENT OF LUSTER OF COTTON. PART XI. DYES AND LUSTER.** Fourt, L.; Elliott, H. J.; and Streicher, P. Textile Research J. *25:* 326–29. 1955.

Luster tends to increase with depth of shade or increasing absorption of light, since this has greater effect on scattering from depth than on front surface reflection. Dyes that form particles on the surface or show more tendency to crack, such as the lake-forming dyes attached to cotton by mordants, show less increase in luster. Vat dyes that increase in crystallinity on soaping show a decrease in luster after soaping (even though the general appearance and quality is improved), indicating increased scattering by larger particles.

1145. **SPECIAL ELASTIC PROPERTIES OF COTTON YARN AND CLOTH MERCERIZED WITHOUT TENSION.** Goldthwait, C. F.; and Murphy, A. L. Textile Research J. *25:* 47–57. 1955.

Suitable cotton yarn or cloth mercerized without tension shrinks, and its elastic properties are changed. Either yarn or fabric in its "shrunk" form shows greater than normal elongation, approximately in accordance with the amount of shrinkage it has undergone. Either tends also to have increased elasticity. This feature is especially notable at low loads in open-weave fabrics, which usually have considerable stretchability after shrinking. Such elasticity is illustrated by a semielastic and conforming cotton gauze bandage that is in successful commercial production. This type of shrunk material, in heavier goods, appears adaptable to other uses, such as base fabrics for coating when elasticity is a required property of the coated fabric.

1139. **IMPROVEMENT OF LUSTER OF COTTON. PART X: SPECIAL SWELLING TREATMENTS AND NONTHERMOSETTING ADDITIVES.** Fourt, L.; and Elliott, H. J. Textile Research J. *25:* 11–19. 1955.

The results of swelling treatments that go beyond mercerizing at ordinary temperature indicate that there is an upper limit to the swelling of cotton with increased luster as the objective. If this is exceeded, the luster is decreased. Drastic shrinkage of yarn volume, combined with film formation and disappearance of fuzz, can leave the fabric very sheer and transparent. Mechanical action on the plastic cellulose, or on films of cellulose or hydroxyethyl cellulose deposited from solution, can give increased luster through flattening and mechanical stabilization in the flattened form. These treatments tend to leave the fabric stiff, if they go beyond normal mercerizing. Other additive finishes act on luster either through film formation or by stabilizing mechanical effects and controlling fabric structure. The more flexible thermoplastic resins can, with mechanical smoothing, produce an increase in the physical measurement of luster.

1004. **BETTER MERCERIZING FOR IMPROVED LUSTER.** Fourt, L.; and Sookne, A. M. Am. Dyestuff Reptr. *43:* 304–9. 1954.

Factors that affect the luster of cotton are reviewed. The mercerizing treatment is the principal means of improvement. Other important factors are variety of cotton chosen and singeing, which can exert an effect about half as great as that of mercerization. Additional small factors that contribute are twist and yarn number. In fabrics, the weave pattern with the longest floats produces the highest luster. The sheerest fabrics are also most lustrous to the eye and in instrumental measurements. The development of tools for measuring luster permits the "tuning up" of the mercerization process in an individual mill.

1074. **THE IMPROVEMENT OF LUSTER OF COTTON. PART IX: THERMOSETTING RESINS.** Fourt, L.; and Elliott, H. J. Textile Research J. *24:* 779–84. 1954.

Effects on the luster of cotton fabrics of typical commercial thermosetting resins, based on urea formaldehyde, melamine formaldehyde, and modifications of these, have been investigated in terms of effects arising directly from the resins and effects arising indirectly, through changes of fabric structure. Indirect effects appear to be as important as the kind of resins used, if not more so. Data show comparative effects of the resins on mercerized and nonmercerized yarns and fabrics; effects of several variations of drying conditions and low-pressure mechanical smoothing; effects of laboratory embossing as compared to effects of tentering and ironing; and effects of resins on wrinkle recovery, stiffness, tensile strength, and tear strength.

1073. **THE IMPROVEMENT OF LUSTER OF COTTON. PART VIII. SELECTION WITHIN COMMERCIAL VARIETIES ON THE BASIS OF FIBER PROPERTIES.** Fourt, L.; Howorth, R. M.; Rutherford, M. B.; and Streicher, P. Textile Research J. *24:* 685–94. 1954.

The possibility of improving the luster of cotton textiles by selecting the raw cotton on the basis of its fiber properties has been demonstrated. Such a method would enable spinners desiring the highest luster to select the most suitable raw cotton. The Cotton Branch, Production and Marketing Administration, USDA, made available for the investigations yarns from cottons representing a large part of the 1952 commercial crop. Low, middle, and high thirds of each of several varieties were selected on the basis of length, wt./in., maturity, or combinations of these properties.

1003. **THE IMPROVEMENT OF LUSTER OF COTTON. PART VII. FIBER PROPERTIES AND VARIETY CHARACTERISTICS IN RELATION TO LUSTER.** Fourt, L.; Howorth, R. M.; Rutherford, M. B.; and Streicher, P. Textile Research J. *24:* 279–91. 1954.

The entire range of American cotton production over 2 crop years has been examined for correlation of luster with other fiber properties. Luster of cotton is shown to be a varietal characteristic, although it is also influenced by environment and growth. The Section of Cotton and Other Fiber Crops of the Field Crops Research Branch of the Agricultural Research Service, USDA, has cooperated. The strongest correlations are of higher luster with greater length, greater strength, and greater roundness. American-Egyptian types, experimental triple hybrids, and Hopi-Acala 50 differ in the relation of fiber properties to luster. The main Upland group, whether rain-grown or irrigated, or long-staple, shows a uniform general trend of relationships. Trends remain generally the same after mercerizing. The most lustrous cottons in the natural state tend to gain most on mercerizing.

1002. **IMPROVEMENT OF LUSTER OF COTTON. PART VI: YARN STRUCTURE IN RELATION TO LUSTER.** Fourt, L.; Howorth, R. M.; Rutherford, M. B.; and Streicher, P. Textile Research J. *24:* 163–72. 1954.

Interrelations of fiber properties and luster have been studied in yarns representing many types of cotton. Results show that the three principal means of improving luster by yarn structure factors are: Lowering of twist; use of optimum plying twist; and singeing to remove free surface fibers. The basic features of staple yarn structure that can vary in cotton yarns include those that depend on fiber factors such as fiber fineness, maturity, and staple length. In comparison with mercerizing, which increases the contrast ratio by 0.7 to 0.8 unit or more in commercial plied yarn, effects are smaller; but they are still important because of the interaction between structure effects and the results of mercerizing.

1001. **IMPROVEMENT OF LUSTER OF COTTON. PART V: FIBER SHAPE IN RELATION TO LUSTER.** Fourt, L.; Howorth, R. M.; Rutherford, M. B.; and Streicher, P. Textile Research J. *24:* 156–63. 1954.

Fiber shape in relation to luster has been investigated, since many of the differences between lustrous cotton fabrics and other lustrous textiles are due to the unique shape of the natural cotton fiber (a flattened, twisted-ribbon structure), which is retained to some degree even after mercerization. The data indicate that the shift of the peak of reflection or the absence of a peak of reflection from cotton yarns and fabrics can be explained by the increased effectiveness of small surfaces acting as mirrors at glancing angles. Mercerizing improves the roundness of cotton and thus reduces the scattering due to tiny planes; it also aids in concentrating light near the mirror angle. Sheerness also increases the appearance of luster by decreasing scattering from depth, and a similar effect is produced by dyeing to darker shades. When the reflection from fabrics is corrected for the change of effectiveness of reflection with angle, the effects of weaving structure are indicated as not one but three peaks of reflection.

1000. **IMPROVEMENT OF LUSTER OF COTTON. PART IV: EFFECT OF WEAVING PATTERN ON LUSTER IN A SERIES OF BLEACHED COTTON FABRICS.** Fourt, L.; and Rutherford, M. B. Textile Research J. *24:* 67–72. 1954.

Luster of cotton fabrics can be influenced by fabric design. Effect of weaving pattern on luster in a series of bleached cotton fabrics manufactured at this Laboratory from the same cotton and processed similarly, in which the pattern varied from plain weave to 4/1 twill, and in number of ends and picks and in yarn fineness, has been investigated by reflectance measurements and by visual ratings. Weaving pattern influences luster through its effects on the length of a given set of yarns lying on the surface, the degree of curvature or straightness of each set, and the number of interruptions by the crosswise set. The longer and straighter the surface floats of the set of yarns that parallels the line of view, the higher the luster. Decreasing texture and cover, using the same yarns, increases luster. In general, sheer or thready fabrics have higher luster than do fabrics made with the same yarns at higher texture or cover. Coarser yarns decrease luster; finer yarns increase it. Thus, if both texture and yarn size are changed but cover is kept constant, the effect on luster is the result of two opposing tendencies; and the changes are smaller than would result from variation in only one factor. Visual judgment of luster generally shows fair correlation with the indications of the contrast ratio.

999. **IMPROVEMENT OF LUSTER OF COTTON. PART III. CORRELATION OF VISUAL AND PHYSICAL ASPECTS OF LUSTER.** Fourt, L.; Howorth, R. M.; and Rutherford, M. B. Textile Research J. *24:* 61–66. 1954.

Comparisons made of measurements of luster with visual judgments confirm that transparency and scattering from the deep layers of the material are important and have measurable effects on luster. Luster depends on sheerness of the fabric as well as on the weave pattern. Light has less opportunity to be scattered within thin layers than in its return from the lower parts of thick layers of yarn. The measurement of contrast ratio in yarns correlates with the average judgment by observers. As for fabrics, the ability of the eye to see sparkle or highlights and to find the angle of maximum reflection gives visual judgment some features not possessed by the simpler types of physical measurement, although there is a large degree of correlation.

913. **IMPROVEMENT OF LUSTER OF COTTON. PART II. DECRYSTALLIZING AND MERCERIZING—INFLUENCE ON LUSTER.** Fourt, L.; and Streicher, P. Textile Research J. *23:* 23–28. 1953.

Anhydrous ethylamine and solutions of sodium hydroxide affect the luster of cotton yarns in the same direction and have similar effects on properties that indicate decrease of crystallinity or increase of accessibility of the cellulose. However, the effect is less for ethylamine under the conditions examined, with this exception: When the yarn is held at nearly constant length by wrapping on plates, with minimum possibility of mechanical action, the ethylamine treatment has more effect on moisture sorption, though less on luster, than does the relatively low degree of mercerization obtained on plates. Tension or control of length is required to produce luster. Luster is increased more by mercerizing after the ethylamine treatment than before the treatment. The stretching of the yarn, made possible by swelling, and the improved fiber roundness are more important for high luster than is the degree of crystallinity change of cellulose.

799. **MERCERIZATION OF YARN—EXPERIMENTAL APPARATUS AND TECHNIQUES.** Goldthwait, C. F.; Murphy, A. L.; Lohmann, I. W.; and Smith, H. O. Textile Research J. *22:* 540–48. 1952.

Balance-type and frame-type apparatuses and general methods for the experimental mercerization of cotton yarn in skeins weighing up to about ¾ pound are described and illustrated. Special techniques, including use of a strain gage, are given for measuring the tension developed in yarn during mercerizing. This measurement is expected to supplement the usual observations of luster, dyeing capacity, and gain of strength of mercerized yarn. Observation of the tension developed can also be employed to indicate the rate of mercerizing and to show differences between cottons.

703. **INFLUENCE OF CROSS-SECTIONAL SHAPE OF RAW COTTON ON DIMENSIONAL CHANGES IN MERCERIZATION WITHOUT TENSION.** Orr, R. S.; Humphreys, G. C.; and Grant, J. N. Textile Research J. *22:* 89–93. 1952.

The relation of the cross-sectional shape of the raw fiber to the changes that occur upon mercerization without tension was studied for a number of cotton varieties representing a wide range of maturities. Perimeters and diameters of fiber cross sections were measured by an especially designed instrument. Areas also were measured. It was found that the percentage of increase in area and the percentage of decrease in perimeter caused by loose mercerization are dependent on the cross-sectional shape of the original raw fibers. Flat fibers shrank more in perimeter and increased more in area than did round fibers. This was partly explained as being caused by a change toward circularity.

701. **EFFECTS OF TENSION ON THE SWELLING OF COTTON FIBERS.** Guiffria, Ruth; and Tripp, V. W. Textile Research J. *22:* 21–25. 1952.

Microscopic measurements showed that the cross-sectional area of cotton fibers tensioned in water and other media increased significantly over that brought about by water-swelling alone. Immersion without tension in urea solution, ethylamine, or sodium hydroxide of mercerizing strength, followed by removal of the reagent and drying, increased area and circularity of fibers compared to untreated fibers; tensioning during immersion increased the circularity but decreased the area as compared to the untensioned fibers. The elongation of fiber bundles tensioned in the various media was measured and was greatest in those tensioned in sodium hydroxide solution.

691. **THE IMPROVEMENT OF LUSTER OF COTTON. PART I. MEASUREMENT OF REFLECTANCE CHARACTERISTICS RELATED TO LUSTER.** Fourt, Lyman; and Sookne, A. M. Textile Research J. *21:* 469–79. 1951.

Practical details are given for using two different instruments for measurement of the reflectance aspects of the luster of cotton yarns. Typical reflectance curves for cotton yarns differing in luster because of mercerization are discussed and compared with the reflectance and visual properties of fabrics made from these yarns. The physical measurements on yarns are much better correlated with what the eye sees in the yarns or in the fabrics than are the measurements on these particular fabrics. This indicates that the study of yarns by these methods is useful for both yarn and fabric. In winding the yarns for examination, a cover factor of more than 40 is needed to eliminate the effect of the backing. Other points of technique, such as tension in winding, humidity, and the size of apertures in the optical system, produce small variations that, however, need to be cared for by standardization of technique when small differences in luster are being examined.

571. **NEW VALUES IN MERCERIZING COTTON.** Goldthwait, C. F. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 427–30.

Mercerization is a process usually employed for producing a permanent high luster on cotton yarn or cloth by treatment with caustic soda solution, with the aid of applied tension or while the material is held under restraint to prevent shrinkage. If, in contrast, the yarn or cloth is allowed to shrink during the treatment, other important properties are imparted to the cotton. Specially mercerized cotton yarn, tire cord, and cloth have increased retention of strength when the cotton is dry; while it is hot; after heating for long periods of time; or during hot flexing. When a surgical gauze is mercerized and allowed to shrink during mercerizing, it can recover elastically from a moderate amount of stretch and "give" when being applied, and it can exert moderate pressure. It conforms readily to the contours of the body, and its nonslip surface causes bandages to stay in place. The latter property, coupled with the elasticity, allows freedom of motion of bandaged joints. The bandage is considered highly successful by those who have used it professionally.

127. **CHEMICAL TREATMENT PRODUCES ELASTIC COTTON GAUZE.** Goldthwait, C. F.; and Kettering, J. H. Textile World *95* (8): 131. 1945.

A surgical cotton gauze bandage with superior elastic properties and clinging powers is described. The new bandage is self-fitting and self-tightening because of the stretchability of the material. The shrinking process used to produce the material is discussed.

128. **SEMIELASTIC COTTON GAUZE BANDAGE FABRIC.** Goldthwait, C. F.; Kettering, J. H.; and Moore, Moore, Jr. Surgery *18*: 507–10. 1945.

The properties and usefulness of a new cotton fabric that is in effect a preshrunk gauze are discussed. A stretchability of 20 percent, together with a nonslip surface texture, makes the material suitable for bandages; and bandages made from it have passed clinical tests in several hospitals. The chemical treatment used to produce the new fabric is described.

Miscellaneous

1817. **HIGH ENERGY γ-IRRADIATION OF VINYL MONOMERS. I. RADIATION POLYMERIZATION OF ACRYLONITRILE.** Arthur, J. C., Jr.; Demint, R. J.; and Pittman, R. A. J. Phys. Chem. *63:* 1366–68. 1959.

Acrylonitrile monomer, in the presence of water and N,N-dimethylformamide, was exposed to high energy γ-radiation from cobalt-60 and high dosage rates ranging from 1.21 to 5.44 x 10^{20} ev./1./min. Increasing radiation dosage, ranging to 2.3 x 10^{24} ev./1., increased the intrinsic viscosities of the polymers rapidly and then, at higher dosages, decreased their intrinsic viscosities exponentially. After an inhibition period, which was decreased with increases in the dosage rate, the rate of polymerization of acrylonitrile monomer was proportional to the dosage rate. In contrast to polymer formation in the presence of water, the polymers formed in N,N-dimethylformamide were completely soluble in the solvent. This may indicate that polymers formed in the presence of water have a higher molecular weight and are more highly crosslinked than are those formed in N,N-dimethylformamide.

1828. **MICROSCOPICAL EVALUATION OF COTTON FINISHING TREATMENTS.** Rollins, M. L.; deGruy, I. V.; Tripp, V. W.; and Moore, A. T. *In* Am. Soc. Testing Materials Symposium on Microscopy, Spec. Tech. Publ. *257:* 153–65. 1959. (77) : 37–38. 1959.

Laboratories of the textile industry expend considerable time and money attempting to improve wrinkle resistance of cotton fabrics. This paper defines the function of the microscopist in these research efforts, which are directed toward both empirical formulation for commercial application and fundamental investigations of reaction mechanisms. After explaining the architecture of the cotton fiber, the authors turn to the different types of cotton finishing—purification of the fiber for removal of noncellulosic substances, and physical modification of the fiber through treatment with chemicals that, by altering the crystalline structure of the fiber, permanently change its properties. The paper considers also additive finishing through coatings or impregnants and finishing through chemical modification of the cellulose that produces new substances without changing the form of the fiber. The paper discusses techniques of staining, cross sectioning, swelling, and dissolution; refractive index determination in optical microscopy; and techniques of replication, fragmentation, ultrathin sectioning, swelling, and dissolution in specimen preparation for electron microscopy. It is supplemented by micrographs illustrative of optical and electron microscope observations.

1838. **REACTION OF EPOXIDES WITH COTTON CELLULOSE IN THE PRESENCE OF SODIUM HYDROXIDE.** McKelvey, J. B.; Webre, B. G.; and Klein, Elias. Textile Research J. *29:* 918–25. 1959.

The reactions of various commercially available epoxides with cotton cellulose in the presence of sodium hydroxide have been investigated at 25°, 50°, and 95° C. The effects of solvents and alkali content of the yarn steep on the epoxy add-on have been studied.

1835. **THE PREPARATION AND PROPERTIES OF PARTIALLY PHOSPHONOMETHYLATED COTTON.** Hobart, S. R.; Drake, G. L., Jr.; and Guthrie, J. D. Textile Research J. *29:* 884–89. 1959.

Cotton fabrics have been phosphonomethylated on commercial scale textile finishing equipment, and the properties of the treated fabrics evaluated. At sufficiently high phosphorus contents, the fabrics have a permanently starched feel and improved wet-crease resistance. Good flame resistance is observed for the ammonium salt form of the fabrics. The treated fabrics are more hydrophilic than are the controls. Stability of the phosphorus content to alkaline treatment is very high. Considerable improvement over untreated cotton in regard to microbiological deterioration is shown by the copper salt form.

1831. **PARTIALLY CARBOXYMETHYLATED COTTON AS AN INTERMEDIATE FOR FURTHER CHEMICAL MODIFICATION.** Reinhardt, R. M.; Reid, J. D.; Fenner, T. W.; and Mayne, R. Y. Textile Research J. *29:* 802–10. 1959.

Cotton can be etherified by treatment with chloroacetic acid and sodium hydroxide solution. The product, a partially carboxymethylated cotton with the fibrous nature of the original, has a number of properties valuable for textile and other uses. In addition, the etherified cotton bears two reactive functional groups—hydroxyl and carboxyl—capable of further chemical modification. The rate and extent of many reactions with the etherified cotton are greater than those of ordinary cotton similarly treated. Further modifications of this cotton derivative are discussed. Among these are salt formation for the preparation of bactericidal and fungistatic finishes; reactions for the introduction of cyanoethyl, carboxyethyl, and graft polyester groups; reaction with epoxy and aziridinyl compounds; and oxidation for the preparation of alkali-soluble textile products.

1837. **RADIATION POLYMERIZATION OF ACRYLONITRILE ONTO COTTON.** Arthur, J. C., Jr.; Demint, R. J.; McSherry, W. F.; and Jurgens, J. F. Textile Research J. *29:* 759. 1959.

In the course of investigations involving the determination of the effects of gamma radiation on cotton cellulose and on polymerization of vinyl monomers, a technique for the application, or possibly grafting, of large, controlled quantities of polyacrylonitrile onto cotton has been developed. Acrylonitrile monomer was uniformly applied to purified 7/3s yarn, Deltapine cotton, and then polymerized by gamma radiation from cobalt-60. The yarns were extracted overnight by N,N-dimethylformamide at 25° C. to remove any monomer and soluble or loosely bound polymer. Polymer contents as high as 26 percent were received.

1806. **CHEMICAL MODIFICATION OF COTTON: AMINIZATION COST STUDY.** McMillan, O. J., Jr.; Decossas, K. M.; Drake G. L., Jr.; Guthrie, J. D.; and Pollard, E. F. Am. Dyestuff Reptr. *48* (17) : 37–38. 1959.

Preliminary cost studies for the continuous production of aminized cotton fabric show that this reactive cotton product can be produced in large quantities at a relatively low cost. Annual production in this hypothetical plant ranged from 6 million to 25.2 million yards to simulate commercial-scale processing. These costs would also be applicable to an occasional output of aminized fabric in a textile-finishing plant with similar equipment, where total annual production of all fabric treatments is approximately equal to 6 million to 25.2 million yards. Chemicals used in this process are readily available at low costs, and conventional textile equipment is quite suitable for fabric processing. For a product containing 0.6 percent of nitrogen, a cost (exclusive of the cost of the fabric and without profit) as low as 20.4 cents per pound of product has been estimated.

1821. **IMPROVEMENT OF WATER-RESISTANT COTTON FABRICS. PART I. METHODS FOR IMPROVEMENT OF CLOSING OF FABRICS BY SWELLING.** Goldthwait, C. F.; and Sloan, W. G. U.S. Dept. Agr. ARS 72–9: 1–13. 1959.

This paper presents considerations of possible improvements of water-resistant cotton fabrics to take advantage of the swelling of the cotton. These considerations include factors in the design, manufacture, and finishing of such fabrics, in their more general aspects. Reasons have been indicated for the selection of various conditions employed in the experimental work to be described in subsequent papers. This more general material was taken up first because nearly every experimental fabric has involved two or more of the main factors or variables.

1822. **IMPROVEMENT OF WATER-RESISTANT COTTON FABRICS. PART II. EVALUATION OF CLOSING EFFECTS OF SWELLING—FABRICS MADE FROM TREATED YARNS.** Goldthwait, C. F.; Murphy, A. L.; and Sloan, W. G. U.S. Dept. Agr. ARS 72–9: 14–25. 1959.

Testing methods employed in these studies are discussed. Special attention is given to adaptations of some of the usual tests for water-resistance to bring out the contribution of swelling. Experimental fabrics discussed in this paper represent 3 different cottons and 16 different yarns, and allow comparisons of loom-state with finished goods throughout; comparisons of fabrics made from mercerized and from unmercerized yarns; comparisons of singles against plied filling yarns; comparisons of cottons with a moderate difference of maturity; and, finally, the effect of an added swellable material.

1823. **IMPROVEMENT OF WATER-RESISTANT COTTON FABRICS. PART III. EFFECTS OF MATURITY OF COTTON AND OF HIGH PICKAGE.** Sloan, W. G.; and Goldthwait, C. F. U.S. Dept. Agr. ARS 72–9; 26–38. 1959.

This paper compares the water resistance of fabrics made from cottons having wide differences in maturity; effects of tightness of weave on water resistance were also investigated. High-pickage fabrics were woven, using a special loom attachment. Three series of fabrics were woven from cottons differing widely in maturity values. In two of these series, high-pickage fabrics were included. Oxford and plain-weave fabrics were compared, and fiber and yarn properties were compared. The effects of different variables on physical properties (other than water resistance) of fabrics were discussed. Comparisons of the effects of different variables were made on loom-state and on finished fabrics.

1824. **IMPROVEMENT OF WATER-RESISTANT COTTON FABRICS. PART IV. USE OF FINER COTTONS AND CLOSER WEAVES—EFFECTS OF FINISHING.** Sloan, W. G.; and Goldthwait, C. F. U.S. Dept. Agr. ARS 72–9: 39–49. 1959.

This paper compares water resistance and other physical properties of fabrics woven from a series of cottons differing in Micronaire fineness from 5.7 to 3.0. While fineness was the basis of selection, the cottons differed in maturity also, but not so greatly as in fabrics used in previous studies. Fabrics containing up to 30 percent more picks per inch were included. Fabrics made from all cottons were compared in the gray, while fabrics from the finest and coarsest cottons were compared after finishing. Fiber and yarn properties are also given. The use of some of these fabrics in experimental water bags was also discussed. The latter part of the paper is devoted to a study of the effects of finishing. This included: (1) Effects of tension and shrinkage; (2) tests at different steps in finishing; (3) final effects of finishing; (4) study of the effect of fabric mercerization on water resistance; and (5) effect of finishing without scouring.

1825. **IMPROVEMENT OF WATER-RESISTANT COTTON FABRICS. PART V. SIGNIFICANCE OF SWELLING.** Goldthwait, C. F.; Buras, E. M., Jr.; and Sloan, W. G. U.S. Dept. Agr. ARS 72–9: 50–61. 1959.

This paper is concerned principally with what happens during finishing to detract from closing capacity of fibers and yarns, viz, with opening or loosening of fabric texture and with reduction of swelling capacity of the cotton. Opening of experimental fabrics was attributed largely to the loss of noncellulosic constituents during scouring rather than to the effects of tension or stretching during finishing. A progressive loss of swelling capacity during finishing was shown by large increases in orifice seepages through samples of yarn taken from fabrics after each step in finishing. This was also shown by a centrifuge technique used to estimate swelling. While both mature and immature fabrics showed a decrease in swelling capacity after each step in finishing, immature cotton showed a greater loss than did mature cotton. Hence, fabrics of immature cotton, which had better water resistance in the gray because of better swelling or closing capacity, are not necessarily more water resistant after finishing. Hydrostatic tests indicated that trapped air in a partially swollen fabric may contribute to water resistance in a way apparently not recognized heretofore, and may not be due merely to the usual water repellency.

1808. **THE CONTINUOUS CARBAMOYLETHYLATION OF COTTON FABRIC: PRELIMINARY COST STUDY.** Decossas, K. M.; McMillan, O. J., Jr.; Reeves, W. A.; Guthrie, J. D.; and Pollard, E. F. Am. Dyestuff Reptr. *48* (14): 30–31. 1959.

This cost study shows that, at an annual production of 60,480,000 yards, cotton can be carbamoylethylated by a continuous method at a cost of 9.1 cents per yard or 16.4 cents per pound of product. Because the process can be accomplished in the usual equipment for resin finishing, these processing costs would apply to any carbamoylethylation at the specified rate that might be done intermittently with other chemical processings in the same equipment. Since the processing costs are based on a new installation, they could be less by as much as the depreciation cost in plants having fully depreciated equipment of the type needed. Depreciation cost represents about 65 percent of fixed cost. The continuous carbamoylethylation process might be particularly attractive to a processor who would want to add another cotton product with special characteristics to his line.

1741. **AN X-RAY STUDY OF PARTIALLY BENZYLATED COTTON CELLULOSE.** Creely, J. J.; Stanonis, D. J.; and Klein, Elias. J. Polymer Sci. *37:* 43–49. 1959.

An X-ray study has been made of partially benzylated cellulose obtained from mercerized cotton yarn, in accordance with a recently developed technique. This study reports the formation of a new crystal lattice for benzylcellulose with a degree of substitution less than 1. This new lattice is indicative of a considerable distention of the original cellulose II unit cell present in the mercerized yarn. Attempts to benzylate ramie fibers under the same conditions resulted in destruction of the fibrous structure by the treatment. Application of heat and tension caused considerable improvement in crystallinity and degree of crystallite orientation of the benzylated cotton. Application of pressure in preparing the sample for X-ray analysis in the usual manner affected the X-ray diffraction pattern, possibly because of distortion of the greatly distended (101) interplanar spacing.

1740. **AN X-RAY STUDY OF NEW CELLULOSE COMPLEXES WITH DIAMINES CONTAINING THREE, FIVE, SIX, SEVEN, AND EIGHT CARBON ATOMS.** Creely, J. J.; Segal, Leon; and Loeb, Leopold. J. Polymer Sci. *36:* 205–14. 1959.

Five new diamine-cellulose complexes have been prepared from cotton by means of tri-, penta-, hexa-, hepta-, and octamethylenediamines. The diamine contents of the dry fibrous materials have been determined, and the characteristic X-ray diffractometer tracings have been obtained. Satisfactory X-ray fiber patterns could not be obtained for the hydrazine, and for the hepta-, and octamethylenediamine complexes. The distention of the 101 interplanar spacing was found to be related linearly to the number of carbon atoms in the diamine molecule. Intensity of the diffraction also increased markedly with diamine chain length. Unit cell dimensions of the new complexes have been calculated. The X-ray data indicating that the 101 interplanar spacing is occupied by only one diamine molecule are supported by the analytical data showing a diamine content close to that required by an anhydroglucose-diamine ratio of 2:1.

1733. **PHOSPHONOMETHYLATION OF COTTON.** Drake, G. L., Jr.; Reeves, W. A.; and Guthrie, J. D. Textile Research J. *29:* 270–75. 1959.

A new phosphorus-containing ether of cotton cellulose has been made by reacting cotton with disodium chloromethylphosphonate in the presence of sodium hydroxide. The degree of substitution can be varied widely by varying the concentration of the phosphonomethylating agent and of the sodium hydroxide and by varying the time and temperature of the cure. Fabric containing up to 3.96 percent of phosphorus was produced by giving the fabric a double treatment. At this degree of substitution, the textile was soluble in water. Up to 2.25 percent of phosphorus was introduced by a single treatment. Generally, the modified cotton becomes water-soluble when about 2 percent of phosphorus is introduced. A permanently starched effect is produced with phosphorus contents of approximately 1 percent. At this degree of substitution, there is little or no change in the breaking strength of the fabric. Modified cotton containing between 1 and 2 percent of phosphorus has greatly increased swelling properties in water. The phosphonomethyl cotton is produced as the sodium salt. It can be converted to the free acid form by soaking or rinsing in dilute mineral acid. The pK_a values for the first and second ionizations are 1.9 and 7.0, respectively. When in the ammonium salt form, the phosphonomethylated cotton has good flame resistance.

1723. **FORMIC ACID COLLOID OF METHYLOLMELAMINE AS A WEATHER- AND ROT-RESISTANT FINISH FOR COTTON.** Berard, W. N.; Gautreaux, G. A.; and Reeves, W. A. Textile Research J. *29:* 126–33. 1959.

A study of application techniques of methylolmelamine resins to cotton has revealed a practical method for producing cotton fabric with outstanding rot resistance and improved weather resistance. This method is based on the use of an acid colloid of methylolmelamine. The method of application of the colloid is the same as that conventionally used for resin finishing; that is, pad, dry, and cure. The main difference is the use of a formic acid to produce a colloid. Photomicrographs show that methylolmelamine colloids (1 to 4 hours old) are deposited in the outer portion of the cell wall of the fiber; whereas the conventional process deposits resin about halfway through the cell wall, and the wet-cure Arigal process deposits uniformly throughout the cell wall. Colloids 5 hours old or older are deposited in much the same position as are those obtained by the conventional process. Only the fresh (1 to 4 hours old) colloids give outstanding rot resistance. Cotton fabric finished with the acid colloids compares favorably with partially acetylated, fully acetylated, cyanoethylated, and Arigal fabrics, which are known to have excellent resistance to rot. Experimental evidence indicates that the mechanism through which rot resistance is acquired by the acid colloid is "controlled penetration" rather than a continuous surface film. Several acids were evaluated for colloid production; formic was the only acid that produced suitable colloids. A number of metal halides have been used as catalysts with the colloids. Small amounts of the metals become tenaciously bound in the fabric, and some of the metals alter outdoor weathering and other properties of the fabric.

1718. **COMPARISON OF THE MECHANICAL PROPERTIES OF COTTON YARNS AND FABRICS TREATED WITH ANHYDROUS ETHYLAMINE AND WITH MERCERIZING CAUSTIC.** Ziifle, H. M.; Eggerton, F. V.; and Segal, Leon. Textile Research J. *29:* 13–20. 1959.

Samples of cotton yarn, tire cord, and fabric were subjected to treatment with anhydrous ethylamine to produce cellulose III. The physical and mechanical properties of these products were compared with those of the untreated materials (containing cellulose I crystal lattice) and of mercerized cotton (containing cellulose II crystal lattice). The ethylamine treatment produced effects upon the textile properties of the original materials which were similar to those of slack-mercerization but smaller percentagewise. The properties of the treated cottons apparently were affected more by the accompanying fiber swelling and yarn shrinkage than by the shift in crystal lattice. Ethylamine-treated bandage gauze compared favorably with the slack-mercerized "conforming bandage" pioneered at the Southern Regional Research Laboratory.

1646. **CHEMICAL MODIFICATION OF COTTON LINTERS FOR PAPERMAKING.** Spadaro, J. J.; Janssen, H. J.; Vix, H. L. E.; and Simons, F. L. TAPPI 41: 674–79. 1958.

A study to determine the papermaking characteristics of chemically modified cotton linters was undertaken as a cooperative project by the Southern Utilization Research and Development Division and Crane and Company. Samples of cyanoethylated and of hydroxyethylated cotton linters at various degrees of substitution were prepared by SURDD, and laboratory-beater evaluated by Crane and Company. The paper describes the methods used for cyanoethylation with acrylonitrile and for hydroxyethylation with ethylene oxide. Results of the beater evaluation tests are given graphically to show the effect of the degree of treatment on the strength characteristics of the prepared handsheets and on beating time and hydration. No appreciable improvements were obtained by the cyanoethylation treatment. The hydroxyethylation treatment, however, gave some very interesting results in that folds (Schopper) of up to 14,000 were obtained, and freeness was decreased to 115 at a beating time of 120 minutes. Tests for the control sample showed 500 folds and a freeness of 220 at a beating time of 180 minutes.

1657. **IODINE SORPTION VALUES OF SOME CHEMICALLY MODIFIED COTTONS.** Bailey, A. V.; Honold, Edith; and Skau, E. L. Textile Research J. *28:* 895–96. 1958.

Some comparative iodine sorption data are reported for partially acetylated, cyanoethylated, and beta-propiolactone-treated cottons. In all cases the iodine sorption capacity increases with the degree of substitution. The results show in general that the iodine sorption values of these chemically modified cottons depend not only on the substituent and the degree of substitution, but also, in the case of the beta-propiolactone-treated cottons, on the method of preparation.

1660. **THE PREPARATION AND PROPERTIES OF PARTIALLY BENZYLATED COTTON.** Klein, Elias; Stanonis, D. J.; Harbrink, Pieter; and Berni, R. J. Textile Research J. *28:* 659–68. 1958.

Ternary systems, such as alcohol, water, and sodium hydroxide, have been used in the pretreatment bath or have been added in fixed quantities to cotton prior to etherification with benzyl chloride. Evidence has been obtained that supports an hypothesis that increased reagent solubility, coupled with control of the cellulose: sodacellulose equilibrium, can lead to essentially homogeneous cotton cellulose modifications. In addition, the experiments have resulted in the preparation of interesting fibrous cellulose ethers. These ethers retained many of the desirable mechanical properties of the original cotton and showed increases in elastic recovery, decreased permanent set, substantivity to disperse dyes, microbiological resistance, and a high degree of thermoplasticity.

1579. **OIL- AND WATER-REPELLENT TREATMENTS FOR COTTON WITH FLUOROCHEMICALS.** Segal, Leon; Philips, F. J.; Loeb, Leopold; and Clayton, R. L., Jr. Textile Research J. *28:* 233–41. 1958.

Further treatments utilizing commercially available fluorochemicals in conjunction with ordinary organic and inorganic compounds have been developed to render cotton fabrics oil- and water-repellent. Application of an acrylic latex to cotton fabrics prior to applying perfluorooctanoic acid chrome complex solutions markedly increased the resistance of the fabrics to wetting by hydrocarbon mineral oils and glyceridic vegetable oils over that previously obtained when using the chrome complex alone at the same concentrations. Oil and water repellency was obtained by using a single emulsion combining nonionic acrylic latices with the chrome complex. High oil repellencies were obtained when fabrics were treated in a single-step process with dilutions of the latices combined with 0.5 percent chrome complex solids. Use of two nonionic acrylic latices indicated that the polymer itself, as well as the solids content of the emulsion, influenced the overall repellency obtained with this treatment. Because the greenish tint imparted by the chrome complex is objectionable for white goods, a colorless treatment employing aluminum acetate and perfluorooctanoic acid was developed. Excellent oil repellency was obtained with cotton fabrics impregnated first with aluminum triacetate and aftertreated with solutions of perfluoro-octanoic acid. Print cloth treated in this manner showed very good resistance to dry soiling and some degree of rot resistance. Fabric construction had a marked influence on the effectiveness of each of the respective treatments. Sateen and whipcord continually required heavier applications of the fluorochemicals to obtain the repellency easily achieved with the lighter constructions.

1581. **PRODUCING ALKALI-SOLUBLE TEXTILE MATERIALS—OXIDIZING PARTIALLY ETHERIFIED COTTONS.** Reinhardt, R. M.; Reid, J. D.; and Fenner, T. W. Ind. Eng. Chem. *50:* 83–86. 1958.

Partially etherified cottons, on oxidation with chromic acid, yield alkali-soluble products. Solubility of the oxidized ethers is dependent on two principal factors: Method of etherification and nature of substituent. Ethers prepared under swelling conditions yield a more soluble product after oxidation. This is probably brought about by the increased accessibility of the oxidizing agent to the ordered regions, which extends its reaction. Hydrophilic ether substituents enhance the solubility of alkali-cleaved fragments of the cellulosic chain. The increase in solubility of etherified cottons permits less drastic oxidation conditions and minimizes loss in physical properties. This results in excellent, usable, alkali-soluble textiles. Adding oxalic acid increases the oxidative activity of chromic acid and reduces time of reaction approximately twentyfold. This addition has no undesirable effects on the physical properties of the alkali-soluble textiles produced.

1583. **REPLACING HYDROXYL GROUPS IN COTTON CELLULOSE.** Klein, Elias; and Snowden, J. E. Ind. Eng. Chem. *50:* 80–82. 1958.

The reaction between cotton cellulose and sulfonyl chlorides to form cellulose sulfonates has been studied to determine the most effective pretreatment methods. The resulting esters are useful intermediates for making new cellulose derivatives in which the cellulosic hydroxyl group has been replaced. Reagents used in the exchange reactions and followed by infrared spectra are phthalimide, toluenesulfonamide, saccharine, phenols and thiophenols, substituted phosphoric acids, halogens, potassium thiocyanate, amines, and nitropropane. Removal of sulfonate groups attached to secondary carbons is discussed, and the effect of acetyl groups on a neighboring carbon is demonstrated.

1501. **THE NONAQUEOUS CARBOXYMETHYLATION OF COTTON.** Reinhardt, R. M.; Fenner, T. W.; and Reid, J. D. Textile Research J. *27:* 873–78. 1957.

Cotton fiber, thread, and fabric were carboxymethylated by a nonaqueous process. Activated cotton was impregnated with an isopropanol solution of monochloro acetic acid and refluxed with 0.3 percent of sodium hydroxide in a mixture of methanol and isopropanol. Degrees of substitution ranging up to 0.09 were achieved. Higher values can be obtained by retreatment or premercerization. Four varieties of cotton fiber have been carboxymethylated by this method. Correlation between the reactivity and the original physical properties of the fibers has been shown. Textile properties of fabric treated by this nonaqueous method and those of a sample treated by the usual aqueous alkali method were compared at equal substitution. The α-methyl-, α-ethyl-, α-propyl-, α-decyl-, and α-cetylcarboxymethyl derivatives of cotton were prepared in low degrees of substitution, using the appropriate α-halocarboxylic acid as the etherifying agent in the nonaqueous reaction.

1420. **A LABORATORY APPARATUS FOR CHEMICAL MODIFICATION OF COTTON YARNS.** Cashen, N. A.; Buras, E. M., Jr.; and DuPré, A. M., Jr. Textile Research J. *27:* 390–92. 1957.

A laboratory apparatus for the chemical processing of cotton yarn that utilizes the excellent heat transfer characteristics of liquid metals to control temperature and minimize problems of local overheating in exothermic reactions is described. Advantages are cited, principal of which is excellent control of temperature and time of treatment.

1412. **THE APPLICATION OF FLUOROCHEMICALS TO COTTON FABRICS TO OBTAIN OIL- AND WATER-REPELLENT SURFACES.** Philips, F. J.; Segal, Leon; and Loeb, Leopold. Textile Research J. *27:* 369–78. 1957.

The application of some fluorocarbon compounds to cotton textiles to impart oleophobic and hydrophobic surface characteristics to the materials has been investigated. Commercial and laboratory preparations of poly-(fluoroalkyl esters of acrylic acid) and of chromium complexes of fluorine-containing monocarboxylic acids were used to treat cotton fabrics, thereby substituting low energy -CF_3 and -CF_2-groups for the -H, the -OH and -CH_2OH of the cellulose surface of the cotton fibers. Data are presented to show the relative effectiveness of several classes of fluorocarbon compounds as satisfactory repellency treatments for cotton fabrics. The data also show that modification of the cellulosic fabric surfaces by use of perfluorocarbon compounds considerably improves the resistance of the fabrics to wetting, not only by water, but also by organic liquids of low surface tension.

1422. **NOTE ON THE DETERMINATION OF THE INSOLUBILITY OF CHEMICALLY MODIFIED COTTON IN CUPRAMMONIUM HYDROXIDE SOLUTION.** Schreiber, W. T. Textile Research J. *27:* 324–26. 1957.

A method is described for determining quantitatively that portion of a chemically modified cotton which is insoluble in cuprammonium hydroxide solution. The samples were treated with cuprammonium hydroxide and then with ammonium hydroxide, followed in each instance by centrifuging and decanting. A filter aid was used to assist in bringing about separation of the insoluble material, and glucose was added to inhibit decomposition.

1413. CARBAMOYLETHYLATION OF COTTON WITH ACRYLAMIDE. Frick, J. W.; Reeves, W. A.; and Guthrie, J. D. Textile Research J. *27:* 294–99. 1957.

Carbamoylethylation of cotton fabric was accomplished by impregnating fabric with an aqueous solution containing 50-percent acrylamide and 4-percent sodium hydroxide, and heating for 4 minutes at 135° C. The fabric contained carbamoylethyl groups that were stable to hydrolysis under standard laundering conditions. On boiling in 5-percent sodium hydroxide solution, 70 percent of the ether groups were cleaved; and the remainder were hydrolyzed to carboxyethyl groups. The carbamoylethylated fabric showed good retention of strip breaking strength, a slight degree of rot resistance, and substantial heat resistance. The fabric could be dyed with Pontamine Blue RRL 175 percent, a direct cotton dye, and with vat dyes without hydrolysis of the carbamoyl groups. The carbamoylethyl groups could be partially converted to amino-ethyl groups by moistening with sodium hypochlorite solution and then drying.

1428. WATER-RESISTANT, WATER VAPOR PERMEABLE COTTON FABRICS. Fourt, Lyman; and Quinn, Frank. Textile Research J. *27:* 232–43. 1957.

The water vapor transmission property of the cotton fiber is used to greatest advantage in plastic-coated, water-resistant fabrics when the coatings are relatively light and are as much as possible located inside the fabric structure, with cotton exposed on each surface. Fabrics such as narrow-wale pique, poplins, drills and twills with prominent twill lines, and napped or pile fabrics, such as suedes or velvets with a substantial backing portion of the fabric, are advantageous. However, light coatings on 80 x 80 print cloth, well scraped into the surface, can also show favorable combinations of relatively low vapor resistance and relatively high hydrostatic resistance. More porous films are produced by a plasticized resin latex with a substantial proportion of water-soluble thickener than are produced by plastisols; but each approach can give a wide range of combinations of properties.

1416. FIBROUS CELLULOSE ESTERS BY TRIFLUOROACETIC ANHYDRIDE METHOD. Hamalainen, Carl; Wade, R. H.; and Buras, E. M., Jr. Textile Research J. *27:* 168. 1957.

Trifluoroacetic anhydride promotes the esterification of cotton cellulose with a wide variety of acids. The preparation of 23 partial esters of cotton cellulose with retention of the yarn form is reported.

1414. CHEMICAL MODIFICATION OF COTTON BY REACTION WITH ACTIVATED OLEFINIC COMPOUNDS. Frick, J. W.; Reeves, W. A.; and Guthrie, J. D. Textile Research J. *27:* 92–99. 1957.

Current interest in the cyanoethylation of cotton with acrylonitrile, an activated olefinic compound, prompted experiments with some similar unsaturated compounds that might be expected to react with cotton to give new and useful products. These investigations indicate that the compounds vary widely in the ease with which they etherify cellulose in a base-catalyzed addition reaction. Acrylamide reacted with cellulose readily. Maleic acid and acrylic acid reacted with cotton but required higher temperatures than did those used for the production of carbamoylethylated cotton. A number of other compounds gave little or no reaction under the conditions used.

1427. A SURVEY OF SOLUBLE CHEMICALLY MODIFIED COTTON FIBERS. Reinhardt, R. M.; and Reid, J. D. Textile Research J. *27:* 59–66. 1957.

Many cellulose derivatives are known to be water- or alkali-soluble. The solubility of these derivatives has been found to be a function of the degree of polymerization, nature of the substituent group, degree of substitution, method of preparation, and type of solvent. A few soluble fibers have been prepared from cotton in which the fibrous form of the cotton is retained during the preparation; that is, the cellulosic hydroxyl group has been chemically modified to a group that confers solubility to the fiber. Hydroxyethylation, carboxymethylation, and oxidation are examples of such procedures; and details of the processes are given. Factors affecting the solubility of chemically modified cotton are discussed, and some of the present uses and possible future uses of soluble fibers are discussed.

1359. PHYSICAL PROPERTIES OF COTTON REACTED WITH *BETA*-PROPIOLACTONE. Nott, E. H.; and Grant, J. N. Textile Research J. *26:* 673–80. 1956.

Cotton yarns were pre-extracted with either acetone or monoethanolamine and reacted with *beta*-propiolactone to secure add-ons in weight up to 36.9 percent. A new type of modified cotton produced by graft polymerization was attained. Certain physical properties of the fibers and yarns were measured. The changes in most properties were found to be associated with the pretreatment, the method of reaction, and the add-on of *beta*-propiolactone. Tenacities of fibers and yarns generally decreased progressively with increase of *beta*-propiolactone add-on. Density decreased linearly with add-on but varied, depending on pre-extraction solvents and methods of treatment used. The rate of degradation of the cellulose by heat was slightly more in the reacted yarns. Frictional resistance of yarns against steel was increased for yarns reacted with *beta*-propiolactone in the presence of xylene, but was unaffected when the alkali method was used. Electron micrographs show polymer on the surface of those fibers reacted in xylene but very little on the surface of those reacted in alkali. Elastic recovery increased 11 to 13 percent with *beta*-propiolactone treatments.

1269. NOTE ON THE PREPARATION OF A PARTIAL ESTER OF COTTON CELLULOSE. Bullock, A. L.; Schreiber, W. T.; and Guthrie, J. D. Textile Research J. *26:* 340–41. 1956.

Although cellulose caprates have been made previously, the processes used degraded the cellulose to some extent, since the objective was to make products that would be soluble in organic solvents. This paper describes a method of preparing a partial capric ester of cotton cellulose in fabric form, employing conditions that do not degrade the cellulose significantly. The method consists of a presoak in pyridine followed by treatment with capric anhydride. Partial esterification was shown by dyeing characteristics and chemical analysis of the modified cotton; by hydrolysis of the treated fabric and determination of the neutralization equivalent of the isolated capric acid; and by the preparation of a derivative of the capric acid recovered from the fabric. The fabric showed considerable water repellency and some rot resistance.

1270. **THE PROPERTIES OF COTTON REACTED WITH *BETA*-PROPIOLACTONE.** Reinhardt, R. M.; Reid, J. D.; and Daul, G. C. Textile Research J. *26:* 1–9. 1956.

A number of the textile and chemical properties of cotton reacted with *beta*-propiolactone have been investigated and are reported. Differences in the properties of the products of the reflux and of the alkali methods of treatment are shown. Reaction of cotton with *beta*-propiolactone yields a cellulose derivative with a bound graft polymer. The results of this unusual reaction are shown by optical means with microscopic cross sections and electron micrographs, by changes in X-ray diffraction patterns, by influence on textile properties, by chemical effects such as saponification to yield carboxyethylcellulose, and by production of unsaturation in the cellulose derivative.

1273. **METHANOLYSIS AND HYDROLYSIS OF COTTON CELLULOSE III.** Nelson, M. L.; Segal, Leon; Mares, T.; and Creely, J. J. J. Polymer Sci. *20:* 29–36. 1956.

The study was undertaken to observe the effects of drastic methanolysis and drastic hydrolysis on the lattice type, crystallinity, and leveling-off degree of polymerization of cotton cellulose III. Well-decrystallized cotton yarn, the remaining organized regions of which consisted predominantly of crystalline cellulose III, was subjected to partial solvolysis in aqueous and methanolic hydrochloric acid. X-ray examination of the residues from partial methanolysis showed that the cellulose III lattice is essentially completely preserved. Viscosimetric data indicated identical values of leveling-off degree of polymerization by hydrolysis and by methanolysis. The data, therefore, neither support nor disprove the idea of recrystallization during hydrolysis, but indicate the need for further work along these lines.

1134. **REACTION OF COTTON WITH *BETA*-PROPIOLACTONE IN THE PRESENCE OF ALKALI.** Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. Textile Research J. *25:* 330–33. 1955.

The reaction of cotton cellulose with *beta*-propiolactone may be effected in the presence of strong alkalies such as sodium hydroxide and potassium hydroxide. Monoethanolamine and trimethylbenzyl ammonium hydroxide will also catalyze the reaction, but to a lesser degree. Diethanolamine and triethanolamine are ineffective. By-products of the reaction are water-soluble and may be removed with a hot-water wash. Conditions of the reaction such as time, temperature, and concentration of reagents, and effect of diluents were investigated and are reported. The products are mixed ethers and esters of cellulose and polyesters thereof, in fibrous form. The ether linkages are stable to saponification, while the ester linkages are broken. Therefore, saponification removes all but the carboxyethyl groups attached directly to the cellulose molecule.

1136. **TREATMENT OF COTTON CELLULOSE WITH AQUEOUS SOLUTIONS OF ETHYLAMINE.** Loeb, Leopold; and Segal, Leon. Textile Research J. *25:* 516–19. 1955.

Aqueous solutions of ethylamine from 70- to 100-percent amine have been investigated as to their effectiveness in reducing the crystallinity of cotton with high cyanoethyl substitution. The density of cyanoethylated cotton is shown to be linearly related to nitrogen content and the spread of values to give an estimate of uniformity of treatment. Cyanoethylated cotton can be dyed by methods developed for polyacrylonitrile fibers, such as those employing acid dyes in the presence of cuprous ion; and the dyed samples so produced are suitable for cross sectioning for microscopic examination. The intensity of dye color can be used as a measure of the amount of cyanoethylation.

1129. **EFFECT OF THE DISTRIBUTION OF METHOXYL GROUPS UPON SOME TEXTILE PROPERTIES OF METHYLATED COTTON FIBER.** Reeves, R. E.; Armstrong, A. C.; Blouin, F. A.; and Mazzeno, L. W., Jr. Textile Research J. *25:* 257–61. 1955.

Cotton methylated with diazomethane to contain 0.25 to 0.95 methoxyl groups per glucose unit retains its wet and dry tensile strength and shows pronounced resistance to rotting in soil-burial tests. Cotton methylated with dimethyl sulfate in the presence of strong alkali fails to show increased rot resistance up to 0.7 methoxyl groups per glucose unit; and, beginning at about 0.5 methoxyl groups, it shows a pronounced loss of wet strength. Those glucose units methylated by diazomethane are located primarily in regions of the fiber readily accessible to aqueous acid hydrolysis, while those methylated by dimethyl sulfate and strong alkali are much more evenly distributed throughout the fiber. For a given methoxyl content, both methods of methylation cause substitution on approximately the same fraction of the glucose units of the fiber.

1141. **INSOLUBILITY IN CUPRAMMONIUM HYDROXIDE AS A MEANS OF DETECTING CROSSLINKING IN CHEMICALLY MODIFIED COTTON.** Reeves, W. A.; Drake, G. L., Jr.; McMillan, O. J., Jr., and Guthrie, J. D. Textile Research J. *25:* 41–46. 1955.

Native cellulose dissolves in cuprammonium hydroxide solution; but, when it is crosslinked, it becomes a space polymer and is insoluble in this reagent. A method of detecting alkali-stable crosslinks in cotton is presented; the sample to be tested is shaken with cuprammonium hydroxide solution for 17 hours. If it dissolves completely, cellulose chains are not crosslinked; but, if it is partially insoluble, crosslinking is indicated. Cellulose was reacted with compounds that contained one or more groups that are reactive toward cellulose. In all cases, the cellulosic derivatives made from cellulose and compounds that could crosslink it were partially insoluble in cuprammonium hydroxide. The compounds that were not capable of crosslinking in cellulose produced derivatives soluble in cuprammonium hydroxide.

1143. **TREATING COTTON WITH VOLATILE AND TOXIC CHEMICALS.** Greathouse, L. H.; Haydel, C. H.; and Janssen, H. J. Ind. Eng. Chem. *47:* 187–91. 1955.

Drawings and detailed instructions are given for the construction of a pilot plant to treat, with volatile and toxic chemicals, sufficient quantities of cotton fiber, yarn, and fabric for product and process evaluation. The unit is designed for versatility, for safety, and for control of pressure, temperature, and flow-rate. Various materials for construction are evaluated for durability. Safety precautions and operating procedures are recommended.

1137. **APPARATUS FOR TREATMENT OF COTTON FABRICS ON A LABORATORY SCALE.** Schreiber, W. T.; and Mason, A. C. F. Am. Dyestuff Reptr. *44:* 288. 1955.

The apparatus described is designed for use in laboratory-scale experiments in which cotton fabrics are chemically treated by exposure to reacting liquids. Its design is such that only a small volume of reagent is required to treat a fabric sample large enough for evaluation by certain physical tests. Temperature and time of exposure can be controlled and uniform exposure of all portions of the sample accomplished.

1135. STUDIES OF THE ETHYLENEDIAMINE-CELLULOSE COMPLEX. I. DECOMPOSITION OF THE COMPLEX BY SOLVENTS. Loeb, Leopold; and Segal, Leon. J. Polymer Sci. *15:* 343–54. 1955.

The ethylenediamine-cellulose complex, previously described by Trogus and Hess, has been reinvestigated regarding its stability toward a series of solvents and the differences in the crystal type and order of the fine structure of the cellulose remaining after decomposition of the complex. It has been shown that the diamine can be almost completely removed from the complex by extraction with any of a series of polar, oxygen-containing solvents. Recrystallization is favored by high temperature during extraction and by high polarity of the solvent used for the decomposition of the complex. The application of these findings to the problem of reducing the crystallinity of cotton cellulose by the decomposition of a swelling complex makes it clear that the method of decomposition and the liquid media employed are important.

1144. SOME DESIGN FEATURES OF A PILOT PLANT CONTINUOUS RANGE FOR CHEMICAL TREATMENT OF COTTON YARN AND FABRICS. Keating, E. J.; Cooper, A. S.; Murphy, A. L.; and Smith, H. O. Am. Dyestuff Reptr. *44:* 65–68. 1955.

A group of basic textile finishing units in a flexible arrangement that can be modified to handle various finishing treatments suggested by laboratory research has been assembled to form a continuous chemical processing range of pilot-plant size. The machine, approximately 32 feet by 4 feet overall, consists of five combination padder-washer units, a hot-air dryer, and a batcher, all of 20-inch face width. The five padder-washer units are identical, each consisting of a 3-roll padder in the center and a washer section on each end to provide numerous variations of utilizing or threading each unit. The machine has been adapted to the partial acetylation of cotton.

1203. WATERPROOFING AND WATER REPELLENCY. Reid, J. D.; and Worner, R. K. *In* Encyclopedia of Chemical Technology *14:* 962–80. 1955. Interscience, New York.

Terminology of waterproofing and water repellency with regard to textiles is reviewed, and impermeable fabrics and water-repellent fabrics are described. The preparation of such fabrics and methods of testing are reviewed. Similar information is given briefly with regard to paper, leather, and masonry. A bibliography is included.

1051. (Pt. I) 1052. (Pt. II) THE REACTION OF COTTON WITH *BETA*-PROPIOLACTONE IN THE PRESENCE OF ORGANIC SOLVENTS. PART I: PURIFIED COTTON. PART II: RAW COTTON. Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. Textile Research J. *24:* 738–43; 744–47. 1954.

This work is part of a study whose objective is to determine whether the application of *beta*-propiolactone to cotton would give it new and useful properties. Part I shows that the reaction of purified cotton with *beta*-propiolactone is affected by time, temperature, and concentration of reagents. In organic solvents, etherification occurs, apparently followed by polyesterification of the attached groups by additional lactone. The reaction could not be directed towards either etherification or esterification by means of acid and base catalysis. The extent of reaction was increased by activation with acetic acid before treatment. Part II shows that noncellulosic alkaline salts present in raw cotton catalyze the reaction and make possible weight gains of over 200 percent. Mercerization, increase in twist, and the presence of waxes and excess moisture adversely affect the concentration of reagents, as with purified cotton. Prepolymerized *beta*-propiolactone will not react to any appreciable extent with raw cotton.

1055. THE CHEMICAL REACTIVITY OF ETHYLAMINE-TREATED COTTON AS INDICATED BY ACETYLATION. Loeb, Leopold; and Segal, Leon. Textile Research J. *24:* 654. 1954.

The full reactivity of the amine-treated and the mercerized cotton could be maintained only if drying was avoided after treatment. When maintained wet with nonaqueous solvent, the reactivity of the amine-treated cotton was of the same order as that of mercerized cotton that had been maintained water-wet after mercerization. The rate of acetylation and degree of substitution obtained with an amine-treated cotton increased strongly as a function of presoak time in glacial acetic acid.

1077. THE USE OF OCTADECYL ISOCYANATE ON COTTON TO PRODUCE WATER-REPELLENCY. Hamalainen. Carl; Reid, J. D.; and Berard, W. N. Am. Dyestuff Reptr. *43:* 453–57. 1954.

The possibility of reacting octadecyl isocyanate (ODI) with cellulose (to obtain a launder-resistant finish for cotton clothing) has been investigated, since such alkyl isocyanates have become available recently on a commercial scale. Cotton cloth may be made superficially water-resistant by use of 2 to 5 percent of octadecyl isocyanate in either organic solvents or aqueous emulsions, if the carrier liquid is evaporated and the treated fabric is then cured with heat, washed, and dried with heat. The extent of isocyanate esterification with cellulose was not determined. Apparently, a large part of the water-repellency is due to the formation of the highly insoluble dioctadecylurea by hydrolysis of the isocyanate. The finish is "shower-resistant" but would not be suitable for use in heavy rainstorms.

1070. A BETTER WAY—THROUGH RESEARCH—TO KEEP DRY UNDER COTTON. Baringer, K. L.; Schuyten, H. A.; and Goldthwait, C. F. Textile Ind. *118* (7) : 102–5. 1954.

Research has been done at this Laboratory on use of water-repellent agents to improve cotton's resistance to penetration by rain and water; and on use of the capacity of wet cotton fibers to swell when wet and thus to close the pores of the fabric, producing self-sealing, water-resistant fabrics. To obtain information on the theory of water-repellency and to explain the chemical reactions by which different agents produce the effect, 332 patents and articles published in the United States and England on water-repellent compounds have been reviewed. An unusual method of measuring water-repellency was devised. Research on swelling-type, self-sealing fabrics led to the development of an unlined (rubberless) firehose. Basic information on cotton fiber swelling has been obtained through application of microscopical techniques. Swelling of cotton has been compared to that of other fibers. The influence of varietal differences, fiber-wall thickness, and degree of maturity on swelling; and the influence of yarn and fabric construction and finishing treatments have been studied. Water-resistant fabrics of this type have been produced.

1071. A SUN-RESISTANT COTTON SHADE CLOTH WILL SAVE DOLLARS FOR TOBACCO FARMERS. Baringer, K. L. The Progressive Farmer *69* (11) : 26. 1954.

A treatment of cotton shade cloth with lead chromate makes it durably sun-resistant. The chemical causes the damaging ultraviolet rays of the sun to become harmless. Lead chromate is inexpensive and can be applied to the cloth by simple processes. Treated cloth has lasted three seasons as top cover in Florida tobacco fields. At least two textile-finishing companies are producing the treated cloth for sale. Shade-tobacco growers in Florida use about 25 million square yards of cotton shade cloth a year. Savings to tobacco farmers through use of improved cloth are estimated at about $200 per acre each season. The availability of the better cotton shade cloth lessens chances that some synthetics will encroach on cotton's market in this field.

1064. ALKYLATION OF CELLULOSE WITH ESTERS OF *p*-TOLUENESULFONIC ACID. Weaver, J. W.; Shirley, D. A.; and MacKenzie, C. A. Ind. Eng. Chem. *46:* 1490–93. 1954.

Preliminary work has established the optimum conditions for the methylation of cellulose with methyl *p*-toluenesulfonate and for the alkylation of sulfonates with alkali cellulose diminished as the length of the alkyl group increased. The ethyl ester brought about a substitution of 1.0 group per glucose unit, while the propyl ester gave only 0.4 group. The butyl and phenyl esters were ineffective as etherification agents for cellulose. Etherification of cellulose with esters of *p*-toluenesulfonic acid is easier to control and requires less care than the usual laboratory preparation employing dimethyl sulfate.

998. CATION-EXCHANGE MATERIALS FROM COTTON AND POLYVINYL PHOSPHATE. Daul, G. C.; Reid, J. D.; and Reinhardt, R. M. Ind. Eng. Chem. *46:* 1042–45. 1954.

Phosphorylated cotton is a new, chemically modified cotton fabric that has promising ion-exchange capacity. A special method of phosphorylation of cotton is described that greatly increases the degree of phosphorylation. A polyhydric alcohol is first phosphorylated, and the cotton is then treated with the product. Four times as much phosphorus can be fixed on cotton, with equivalent strength loss, by this treatment as by the usual urea-phosphate treatment. A cation-exchanger is produced that compares favorably with commercial cation-exchangers.

931. PREPARATION OF SOLUBLE YARNS BY THE CARBOXYMETHYLATION OF COTTON. Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. Textile Research J. *23:* 719–26. 1953.

Water- and alkali-soluble cotton fibers, yarns, and threads can be prepared by either a one-step or two-step method. The cotton (preferably) is pretreated by pressure kiering in 2-percent sodium hydroxide to remove noncellulosic materials and treated with monochloroacetic acid and sodium hydroxide; then, where only disintegration or partial solubility is required, the one-step method is sufficient. But, where complete solubility of the cotton is required, the mild treatment must be followed by a stronger one. The treated cotton is neutralized in alcohol with acetic acid to produce water-soluble products or with strong acids in alcohol to produce water-insoluble but alkali-soluble products. Cotton sliver, yarn, and thread have been successfully treated.

933. ETHYLENIMINE-TREATED COTTON. Drake, G. L., Jr.; Reeves, W. A.; and Guthrie, J. D. Textile Research J. *23:* 639–41. 1953.

Raw cotton fiber in the form of card sliver was treated in an evacuated oven with the vapor of ethylenimine. The ethylenimine polymerized in or on the fiber and enhanced its ability to be dyed with acid dyes, but apparently there was little true chemical combination between the imine and the cellulose. Fiber treated in this way, along with appropriate controls, was converted into fabric that was evaluated by various test methods. The results show that cotton may be treated with ethylenimine without adverse effect on the fabric made from it; but, aside from changed dyeing characteristics, no outstanding property has yet been noted for ethylenimine-treated cotton.

935. CHEMICAL AND PHYSICAL PROPERTIES OF AMINIZED COTTON. Reeves, W. A.; McMillan, O. J., Jr.; and Guthrie, J. D. Textile Research J. *23:* 527–32. 1953.

Chemical reactions of aminized cotton differ from those of untreated cotton. Aminized cotton takes on most cotton dyes very rapidly; and some of these, especially direct dyes, are more resistant to light and laundering on aminized than on untreated cotton. Although acid dyes are taken readily by aminized cotton, they are not fast to laundering. Combustibility of aminized cotton can be reduced either by application of dyes containing a phosphate or a sulfo radical or by reacting the amino groups with tetrakis(hydroxymethyl)phosphonium chloride. Certain metals react with the amino groups to form metal complexes that have oxygen-exchange properties. Aminized fabric can be given considerable rot-resistance by reacting with 8-hydroxyquinoline-5-sulfonic acid and then chelating with copper. Aminized cotton reacts with *ortho*- and *para*-nitrochlorobenzenes in dilute solutions.

934. AMINIZATION OF COTTON. Reeves, W. A.; and Guthrie, J. D. Textile Research J. *23:* 522–27. 1953.

Methods are described for the aminization of cotton raw stock, sliver, yarn, and fabric by curing with 2-aminoethylsulfuric acid in the presence of sodium hydroxide. Fabric may be aminized on standard cotton-chemical finishing equipment. Sliver aminized by the process described may be opened, recarded, and converted into yarn. Sodium hydroxide solutions of 30- to 35-percent strength usually give greater aminization than a 25-percent solution; and a 20-percent solution of 2-aminoethylsulfuric acid can almost double the degree of aminization obtained with a 10-percent solution. Experiments on aminization of compounds related to 2-aminoethylsulfuric acid and observations on other methods of aminization are reported.

922. EFFECT OF A WETTING AGENT ON THE HYDROLYSIS OF HIGHLY METHYLATED COTTON CELLULOSE. Reeves, R. E.; and Barrett, B. J. Textile Research J. *23:* 510–12. 1953.

The acid-catalyzed, heterogeneous hydrolysis of a highly methylated cotton cellulose has been investigated, with attention to the effect of incorporating a wetting agent in the hydrolysis medium. The amount of fast-reacting material was small when the aqueous acid did not contain a wetting agent but was increased in the presence of an active wetting agent. The rate constant for the slow-reacting material was also increased by the wetting agent. The minimum viscosity reached during hydrolysis was the same with or without the wetting agent.

860. VISCOSITY, SEDIMENTATION, DIFFUSION, AND OSMOTIC BEHAVIOR OF LONG-CHAIN NITROCELLULOSE MOLECULES. Newman, S.; Loeb, Leopold; and Conrad, C. M. J. Polymer Sci. *10:* 464–87. 1953.

The intrinsic viscosity, sedimentation, diffusion, and osmotic properties of four long-chain unfractionated nitrocellulose polymers have been compared. These comparisons were made to investigate (1) the relation between molecular weight as determined by absolute methods and intrinsic viscosity, based on long-chain celluloses nitrated in a reproducible manner but differing widely in molecular weight; (2) the effect of rate of shear on intrinsic viscosity of samples giving non-Newtonian solutions; (3) how the data fit in with theory regarding the behavior of flexible linear macromolecules in dilute solution; and (4) the interrelation of some results of the concentration dependence measurements in terms of fundamental molecular parameters. Results affirmed the existence of a marked shear dependence of intrinsic viscosity increasing with molecular weight, and validated viscosity techniques.

859. **DETERMINATION OF THE LEVELING-OFF DEGREE OF POLYMERIZATION OF COTTON AND RAYON.** Nelson, M. L.; and Tripp, V. W. J. Polymer Sci. *10:* 577–86. 1953.

Effects of varying hydrolytic conditions on change in estimated degree of polymerization of cotton linters and viscose rayon have been explored by varying the acid concentration downward over the range of 2.5 *N*. to 0.01 *N* and by carrying out the hydrolysis at 100° and 80° C. The temperature and acid concentration did not affect appreciably the leveling-off DP but affected the rate of hydrolysis. An alternative way of determining the leveling-off DP is presented in which the leveling-off DP is considered that value on the curve of DP versus residue percentage, under conditions of continuous hydrolysis, at which the slope of the tangent to the curve first attains a minimum absolute value. Moisture regain data on the hydrocelluloses indicate that either in the aqueous hydrolytic medium or during drying cotton linters may recrystallize slightly, while rayon does so in a significantly greater amount.

787. **THE HETEROGENEOUS HYDROLYSIS OF HIGHLY METHYLATED COTTON CELLULOSE.** Reeves, R. E.; Barrett, B. J.; and Mazzeno, L. W., Jr. J. Am. Chem. Soc. *74:* 4491–94. 1952.

Upon heterogeneous hydrolysis highly methylated cotton celluloses decrease sharply in viscosity (in chloroform solution); pass through minimum values; and, upon prolonged hydrolysis, show increases in viscosity. Different minimum viscosities for different batches of methyl cellulose are attributed to different crystallite dimensions produced during the methylation procedure; this explanation is supported by the X-ray diffraction patterns of the methyl celluloses. The initial viscosity decreases are regarded as due to the more rapid destruction of the lowest viscosity material.

840. **ALCOHOLYSIS OF CELLULOSE WITH 2-METHOXYETHANOL.** Blair, M. G. J. Am. Chem. Soc. *74:* 3411–14. 1952.

The extent of cleavage that can be obtained with 2-methoxyethanol, a new alcohol, which does not appear to have been used previously for the alcoholysis of any polysaccharide, has been investigated. Its high reactivity makes this alcohol worth consideration as an alcoholytic reagent for polysaccharides, particularly since use of an autoclave is not required to reach the optimal reaction temperature.

801. **ION-EXCHANGE COTTONS.** Guthrie, J. D. Ind. Eng. Chem. *44:* 2187. 1952.

Phosphorylated cotton, made by the action of phosphoric acid and urea, is a cation-exchanger with pH values at half capacity of 1.5 and 7.5 for the first and second hydrogen. Sulfoethylated cotton, made by the action of 2-chloroethylsulfonic acid in the presence of sodium hydroxide, is a cation-exchanger of the strong acid type, having a pH value at half capacity of 0.5. Partially carboxymethylated cotton and the succinic acid half ester of cotton are cation-exchangers of the weak acid type having pH values at half capacity of 3.7 and 4.8. Anion-exchangers include: Aminized cotton, made by the action of 2-aminoethylsulfuric acid in the presence of sodium hydroxide; aminized-iminized cotton, made by the action of ethylenimine on aminized cotton; and quaternary aminized cotton, made by the action of methyl iodide on diethylaminoethylated cotton. Possible uses of ion-exchange cottons in the form of loose fiber, roving, yarn, or fabric are discussed.

796. **STUDIES ON THE PARTIAL CARBOXYMETHYLATION OF COTTON.** Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. Textile Research J. *22:* 787–92. 1952.

Additional studies of partial carboxymethylation of cotton showed that relatively small amounts of monochloroacetic acid, properly applied, alter the properties of cotton considerably. Pilot-scale carboxymethylation of cloth showed that it is possible to use standard textile machinery in the process. The cloth resulting from this treatment had a crisp hand with a slightly starched feel. The tensile strength and elongation of treated cotton were increased, dyeing properties were changed, soiling-resistance and soil removal were increased; and the treated materials were unaffected after 1 year's storage.

788.1. **ACTION OF CYANURIC CHLORIDE ON COTTON CELLULOSE.** Warren, Jane; Reid, J. D.; and Hamalainen, Carl. Textile Research J. *22:* 584–90. 1952.

The reaction of cyanuric chloride with alkali-treated cotton cellulose has been examined to determine the effect of reaction conditions on degree of substitution and on retention of chlorine for further modification. Type of alkali pretreatment and choice of organic solvent were found to influence the reaction. The highest substitution obtained was 1 triazine ring per 1.9 anhydroglucose residues, based on nitrogen content. Although the highest chlorine content was 1 chlorine atom per 3.4 anhydroglucose residues, this residual chlorine was stable to heating at 101° C. and to several months of storage, and was capable of reacting with ethylenediamine and hexamethylenediamine. Strength loss during treatment was low and in no case exceeded 26 percent of the original. A change in dyeing properties was related to degree of triazine substitution in some cases and to type of pretreatment in others. The treated yarn had some resistance to microbiological attack.

706. **FORMATION OF CELLULOSE ETHERS IN WATER-REPELLENCY TREATMENT OF COTTON WITH STEARAMIDOMETHYLPYRIDINIUM CHLORIDE.** Schuyten, H. A.; Weaver, J. W.; Frick, J. G., Jr.; and Reid, J. D. Textile Research J. *22:* 424–32. 1952.

The chemical reactions that take place between cotton cellulose and stearamidomethylpyridinium chloride and those of any compounds that form from this chloride in the treating bath or on cloth under the usual treating conditions were studied. Stearamidomethylpyridinium chloride and each of the possible compounds were synthesized and applied separately to the cloth in a manner as similar as possible to the commercial treatment. Stearamidomethylpyridinium chloride reacted with cellulosic hydroxyl groups to produce a stearamidomethyl ether of cellulose. Substitution of 1 stearamidomethyl group per 150 anhydroglucose units was obtained. The permanent water-repellency obtained on treatment of cotton fabrics with amidomethylpyridinium salts is due to this reaction.

718. **WHITES FROM CHLORINE AND PEROXIDE BOTH "PERMANENT."** Kraemer, Rita; and Goldthwait, C. F. Textile World *102* (3): 159, 246. 1952.

A long-term test of the relative permanency of the whites obtained with chlorine and with peroxide bleaches was made in which samples were stored with and without access of light. The fabrics, whether bleached with chlorine or peroxide, retained their whiteness equally well under each storage condition.

716. **ATTACHMENT OF DYES TO COTTON BY ETHER LINKAGE.** Guthrie, J. D. Am. Dyestuff Reptr. *41:* 13–14, 30. 1952.

A method is described for coloring cotton by attaching certain azo dyes to the cellulose by ether linkage. The dyes contain the sulfatoethyl group and are reacted with cotton by curing in the presence of strong sodium hydroxide. Such dyes were prepared from 2-(*p*-aminophenoxy) ethylsulfuric acid. Cotton fabric colored by the process has outstanding washfastness. While the lightfastness is only fair, it is about equal to that of cotton fabrics dyed with commercially developed azo colors.

640. **SPECTROPHOTOMETRIC EVIDENCE FOR THE ABSENCE OF FREE ALDEHYDE GROUPS IN PERIODATE-OXIDIZED CELLULOSE.** Rowen, J. W.; Forziati, F. H.; and Reeves, R. E. J. Am. Chem. Soc. *73:* 4484–87. 1951.

Infrared absorption spectra were obtained with mineral oil slurries of periodate-oxidized cotton cellulose and with the periodate-oxidation product from methyl 4, 6-benzylidene-*α*-D-glucopyranoside. These spectra show little change in the region of the spectrum in which the intense absorption of the C=O stretching vibration occurs, the 5.5- to 6.5-micron region. The results suggest either that the absorption of aldehydic carbonyl in this periodate-oxidized material is of unusually low intensity or that few, if any, aldehyde groups as such are present. A likely explanation of these data is that at least one and possibly both of the aldehyde groups of the oxidized anhydroglucose units have reacted with water, forming hydrates. The unhydrated aldehyde groups may have reacted with residual alcohol groups to form hemiacetal groups.

521. **A COLD-SOLVENT EXTRACTOR.** Buras, E. M., Jr. Textile Research J. *21:* 433–34. 1951.

A compact, leakproof modification of the Soxhlet extractor is described and illustrated. It is said to be satisfactory for the solvent extraction of material on a laboratory scale at room temperature or below.

537. **THE HETEROGENEOUS HYDROLYSIS OF METHYL CELLULOSE.** Reeves, R. E.; and Mazzeno, L. W., Jr. Textile Research J. *21:* 168–69. 1951.

It is pointed out that the published data of Steele and Pacsu on the rate of heterogeneous hydrolysis of methyl cellulose are in accord with the concept of a single reaction having an apparent activation energy of approximately 18 kilocalories per mol, the rate of which is primarily determined by the physical state of the substrate.

528. **THE ORIFICE TEST AS A METHOD FOR STUDYING CLOSING CAPACITY OF COTTON FIBER IN THE RAW STATE.** Scott, L. W.; Barrett, D. J.; and Rollins, M. L. Textile Research J. *21:* 148–55. 1951.

A modified orifice test is described that compares the closing capacities of cotton samples by measurement of the seepage of water under pressure through a bundle of parallelized fibers confined in the orifice. There is a good correlation between this orifice test on fibers and the original test on yarns, which was described in a previous publication. Thus, the extensive process of yarn spinning may be unnecessary in a test for the prediction of the effectiveness of different cottons intended for use in products whose primary purpose is to resist penetration by water. The phenomenon of closing capacity is shown to be determined by the interplay of the effective amount of air space per unit weight of fiber in the orifice; the swelling of individual fibers; and the size and number of minute spaces between fibers.

540. **GLYCOSIDIC METHOXYL GROUPS IN METHANOLYZED CELLULOSE.** Reeves, R. E.; Mazzeno, L. W., Jr.; and Hoffpauir, C. L. Textile Research J. *21:* 78–81. 1951.

Oxidation by a glycol cleavage reagent has proved that the acid-labile methoxyl groups in methanolyzed cellulose are linked in glycosidic combination (one per molecule) and not in an acetal structure that would require two such groups per molecule. Evidence confirming the glycosidic structure was obtained by fractionating methanolyzed cellulose to the point where number-average molecular weights must be calculated on the basis of one methoxyl group per molecule. The rate of removal of methoxyl groups from methanolyzed cellulose on acid hydrolysis was roughly comparable to the rate of hydrolysis of methyl glucopyranosides. These findings contradict a claim, based on copper-number determinations, that the methoxyl groups of methanolyzed cellulose are very rapidly hydrolyzed and are of the acetal type.

532. **REACTION OF FORMALDEHYDE WITH COTTON.** Goldthwait, C. F. Textile Research J. *21:* 55–62. 1951.

Partially methylenated cottons were prepared by the reaction of cotton with formaldehyde under acid conditions in nonaqueous (mainly acetone) solutions. The modified cotton, although it did not differ from ordinary cotton in appearance and general textile character, displayed new properties even at relatively low formaldehyde contents (from 0.5 percent to 1.5 percent) that may prove of practical importance. Dye-resisting yarns of possible technological interest can be produced, apparently because of crossbonding in the cellulose. The modified cotton has a decreased swelling capacity in water and other swelling agents. Products of sufficient formaldehyde contents have good resistance to biological rotting. Direct cotton dyes are made faster by the treatment.

541. **STABILIZATION OF NEUTRAL HYPOCHLORITE-OXIDIZED COTTON FIBER.** Reeves, R. E.; and Jung, J. R., Jr. Textile Research J. *21:* 22–25. 1951.

Cotton fiber oxidized by neutral hypochlorite solution, like cotton fiber oxidized by periodate, suffers two types of damage. One type is immediately evident; the other is latent and becomes evident after exposure of the oxidized fiber to aqueous alkali. When fiber oxidized by neutral hypochlorite is treated with ethereal diazomethane before exposure to alkali, a portion of the latent damage does not develop. The oxidized and treated fiber displays lower alkali solubility, lower cuprammonium fluidity, and greater strength after exposure to alkali than does the fiber oxidized but not treated. Chlorous acid, found effective against the latent damage in periodate-oxidized cotton, is without effect against the latent damage in hypochlorite-oxidized cotton.

689. **SPECTROPHOTOMETRIC DETERMINATION OF CARBOXYL IN CELLULOSE.** Forziati, F. H.; Rowen, J. W.; and Plyler, E. K. J. Research, Natl. Bur. Standards *46:* 288–91. 1951. (Research Paper No. 2197.)

A method that uses the intensity of the absorption of the oxidized celluloses at 5.8 microns as a measure of their carboxyl content is described. The analyses are carried out on mineral oil slurries of 1:1 mixtures of finely divided polystyrene and cellulose. The absorption of the polystyrene at 6.2 microns is used as a reference band, thus obviating the necessity of accurately controlling the thickness of the absorption cell. The method gives results that agree fairly well with those obtained by the calcium acetate method and can be used to detect as little as 0.1 millimole of carboxyl per gram of cellulose.

574. **HOW TO KEEP DRY UNDER COTTON.** Reid, J. D.; and Goldthwait, C. F. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 411–18.

Water-repellent cotton fabrics are described with review of various chemical methods by which the cotton may be made water-repellent. Self-sealing fabrics that approach watertightness through sealing themselves by swelling as they become wet are also described. In some cases, this is accomplished by addition of a swellable cellulose ether to the fabrics; in other cases, differences in weave or maturity of cotton will contribute to self-sealing.

484. **THE HETEROGENEOUS METHANOLYSIS OF NATIVE AND MERCERIZED COTTON CELLULOSE.** Reeves, R. E.; Mazzeno, L. W., Jr.; and Hoffpauir, C. L. J. Am. Chem. Soc. *72:* 4773–77. 1950.

The methanolysis of cotton cellulose produces two measurable results: Introduction of acid-labile methoxyl groups into the insoluble phase and dissolution of a portion of the cellulosic material into the methanolysis reagent. When methanolysis is considered as the sum of these two effects, it is found that the rate of methanolysis smoothly decreases in the region where 0.1 to 5 percent of the glucose units have undergone reaction. Throughout this investigated region, the temperature coefficient for native cotton cellulose remained constant; for mercerized, a lower, essentially constant value was observed. It appears that the rate-controlling step in methanolysis involves, at a single step, the rupture of secondary as well as primary valence forces. The data are explicable in terms of reaction with an initially large crystalline surface, diminishing strongly as the surface is reduced by the coalescence of crystalline areas when internal tensions relax because of reaction within the fiber.

441. **FLEXIBILITY OF NITROCELLULOSE MOLECULES IN ACETONE.** Newman, Seymour. J. Phys. Colloid Chem. *54:* 964–66. 1950.

Published sedimentation data show that the hydrodynamic equations for flexible macromols of Kirkwood and Riseman (Chem. Abs. *43:* 7781d) are applicable to nitrocellulose in acetone. By means of these equations, the intrinsic viscosity values of the samples of Badger and Blaber (Chem. Abs. *44:* 906) were calculated and found to be in satisfactory agreement with observed values.

485. **THE PREPARATION OF WATER- AND ALKALI-SOLUBLE COTTON YARNS.** Reid, J. D.; Daul, G. C.; and Reinhardt, R. M. Textile Research J. *20:* 657–59. 1950.

Press reports confused two types of soluble yarns produced at the Southern Regional Research Laboratory. This Letter to the Editor differentiates between alkali-soluble metal carboxymethylcellulose fibers and the new water- or alkali-soluble modified cotton yarns. A typical method of preparation of the latter is described.

481. **ION-EXCHANGE CHARACTERISTICS OF CHEMICALLY MODIFIED COTTON FABRICS.** Hoffpauir, C. L.; and Guthrie, J. D. Textile Research J. *20:* 617–20. 1950.

The pH at which an ion-exchanger exhibits half its maximum capacity corresponds to the half-neutralization point of the exchanger and is a means of rating ion-exchangers independent to their capacity. The variation in the ion-exchange capacity of a number of chemically modified cotton fabrics as a function of pH was determined. Phosphorylated cotton fabric behaved as a dibasic acid with acid strength comparable to that of the first and second hydrogen of phosphoric acid. Partially sulfethoxylated cellulose was a cation-exchanger of high acid strength while carboxymethylated cellulose and the succinic acid half ester of cellulose were weakly acidic cation-exchangers. Aminoethyl cellulose, a primary amine, and diethyl aminoethyl cellulose, a tertiary amine, were weakly basic anion-exchangers. Treatment of diethyl aminoethyl cellulose with methyl iodide gave a quaternary compound that served as an anion-exchanger of high basic strength.

443. **STABILIZATION OF PERIODATE-OXIDIZED COTTON.** Reeves, R. E.; and Darby, F. F., Jr. Textile Research J. *20:* 172–74. 1950.

Earlier observations regarding the stabilization of periodate-oxidized cotton fiber by treatment with chlorous acid or ethereal diazomethane are confirmed; and evaluation of the treatments has been extended to cotton sewing thread. At low levels of oxidation, the treated samples retain considerably more strength after exposure to sodium carbonate solution than do samples oxidized but not given a stabilization treatment. At high levels of oxidation, the stabilizing treatments produce good reductions in alkali solubility.

403. **INSECTPROOFING COTTON BAGS.** Cotton, R. T.; Frankenfeld, J. C.; and Strickland, W. B. U.S. Dept. Agr., Bur. Entomol. Plant Quarantine E–783, 4 pp. 1949. (Processed.) Republished, Textile Ind. *113* (10): 94, 264–66. 1949; Modern Packaging *23* (3): 126–27. 1949.

These experiments show that bags made from cotton treated with extremely light doses of pyrethrins, alone or mixed with piperonyl butoxide, will protect flour packed therein from insect infestation for at least 7 months. These chemicals are of a comparatively low order of toxicity to warmblooded animals, and it seems unlikely that at the rates and methods of applications used they would contaminate products packed in the treated bags. Manufacturers of fabrics for cotton bags may find it possible to treat warp yarns during sizing at no additional cost other than that of the chemicals used.

406. **THE PREPARATION AND PROPERTIES OF ALKALI-SOLUBLE METAL CARBOXYMETHYLCELLULOSE FIBERS.** Reid, J. D.; and Daul, G. C. Textile Research J. *19:* 794–801. 1949.

It is shown on a laboratory scale by a method suitable for use in lecture demonstration work and on a pilot-size spinning-machine, that metal carboxymethylcellulose can be produced from sodium carboxymethylcellulose and suitable metals that are capable of cross-linkage to yield fibers with strengths ranging from 1 to 2 g. per grex. A mixed copper-aluminum carboxymethylcellulose fiber possessed the best strength, appearance, flexibility, feel, and like characteristics. The fiber resembles alginic acid fibers and might prove suitable for novelty fabrics and similar uses where an alkali-soluble fiber is desired.

384. **CELLULOSE-WATER RELATIONS: A SELECTED BIBLIOGRAPHY WITH SPECIAL REFERENCE TO SWELLING OF COTTON AND TO ITS UTILIZATION IN WATER-RESISTANT FABRICS.** Rollins, M. L.; Fort, H. H.; and Skau, D. B. U.S. Dept. Agr. Library List No. 44, 63 pp. March 1949.

The swelling of cotton fibers by absorption of water contributes to such effects as variation in the strength of yarn with humidity and the shrinkage of cloth when not suitably finished. While it is not always an advantage, this swelling property has recently been utilized as an aid in closing the minute interstices in cotton fabrics that must be resistant to the passage of water. However, improvement of the water resistance of cotton goods by means of swelling is so new that the required properties of fibers have not yet been well correlated with the properties needed in the fabrics. This bibliography is intended to help bridge this gap by providing selected references on the swelling of cotton and other fibers and on methods for estimating or measuring this swelling.

368. **THE USE OF AMINIZED AND PHOSPHORYLATED COTTON FABRICS AS ION-EXCHANGE MATERIALS IN THE PREPARATION OF OIL SEED PROTEINS.** Hoffpauir, C. L.; and Guthrie, J. D. J. Biol. Chem. *178:* 207–12. 1949.

Protein preparations low in ash and phosphorus content may be made by the use of anion-exchange materials to increase the pH of oil seed meal suspensions and cation-exchange materials to reduce the pH of the protein dispersion to the isoelectric range. Preparations very low in ash and phosphorus may be obtained by the alternate use of aminized cotton fabric and phosphorylated cotton fabric until deionization is almost complete prior to separation of the protein curd. The method is also useful for the purification of protein preparations made by the usual methods. While commercial ion-exchange resins may also be used, the results with the fabrics have been better. The fabrics are also more convenient and are readily recovered and regenerated.

305. **BLEACHING METHODS COMPARED BY LABORATORY ANALYSES.** Kettering, J. H. Textile World *98* (4): 139, 224, 225, 226, 228, 229. 1948.

An investigation was undertaken to obtain comparative data on the three general classes of bleaching procedures in use. Eleven mill processes, as applied to the bleaching of cotton cloth, representing (1) the caustic-soda kier boil and hypochlorite bleach, (2) the caustic-soda kier boil and peroxide kier bleach, and (3) the continuous processes using hydrogen peroxide of chlorite, were surveyed and compared by analyses of the fabrics. Results are tabulated.

339. **THE PARTIAL CARBOXYMETHYLATION OF COTTON TO OBTAIN SWELLABLE FIBERS, II.** Reid, J. D.; and Daul, G. C. Textile Research J. *18:* 551–56. 1948.

Previously reported research by the same authors was extended to determine the effect of partial carboxymethylation on cloth treated in the piece and on cloth woven from treated yarn. Cloth treated without tension had satisfactory hand and feel, lower water permeability, and greater air permeability than did untreated material; cloth treated under tension had even greater air permeability, but the decrease in water permeability was slight. Cloth was successfully woven from treated plied yarn, but the expected decrease in water permeability was not attained with the carboxymethyl substitution and the weaves used. Treated cloth absorbed water two to three times as fast as did untreated cloth, but it took up only a little more than the total amount absorbed by a mercerized control; and the drying rate was about the same. Carboxymethylation of cotton alters its dyeing characteristics and may serve as a starting point for other chemical changes.

341. **IMPARTING WATER-REPELLENCY TO TEXTILES BY CHEMICAL METHODS: A REVIEW OF THE LITERATURE.** Schuyten, H. A.: Reid, J. D.; Weaver, J. W.; and Frick, J. G., Jr. Textile Research J. *18:* 396–415; 490–503. 1948.

This is a review of 332 references gathered from the patent literature and from several selected journals on the production of water repellency by chemical methods. (A related index of compounds used to obtain chemical water repellency was published by the U.S. Department of Agriculture in June 1948 as AIC–179.) Only those processes were considered that involve a chemical reaction of the water-repellent agent with the textile fabric or with itself to give a fabric more or less repellent to water but permeable to air. These methods are not evaluated. References are divided into groups according to the nature of the water-repellent agents discussed. The group dealing with acid halides, anhydrides, and other esterifying agents, and the group dealing with quaternary nitrogen compounds, are included in the first part of the article. The second half of the article continues the discussion of water-repellent agents by groups as follows: Esters and urethanes; amines, amides, and related compounds; aldehydes; polymers formed *in situ;* ethers, epoxides, and related compounds; cyanates, thiocyanates, and related compounds; urea derivatives; and silicon derivatives and miscellaneous compounds.

301. **AN ORIFICE TEST TO EVALUATE YARNS FOR SWELLING-TYPE WATER-RESISTANT FABRICS.** Smith, H. O.; Murphy, A. L.; and Goldthwait, C. F. Textile Research J. *18:* 124–29. 1948.

A detailed description is given of the apparatus and test procedure used in applying the Southern Regional Research Laboratory's method for comparing the swelling or closing capacities of textile fibers and yarns through the use of orifices. Essentially, the test measures the seepage of water under pressure through a bundle of yarn packed tightly in an orifice. It has been applied successfully to yarns from different cottons, to yarns modified by mercerization or other chemical treatment, to cotton yarns whose swelling has been supplemented by the addition of swellable but insoluble materials, and to a lesser extent to yarns made from other cellulose fibers.

307. **PHOSPHORYLATED COTTON CELLULOSE AS A CATION-EXCHANGE MATERIAL.** Jurgens, J. F.; Reid, J. D.; and Guthrie, J. D. Textile Research J. *18:* 42–44. 1948.

Methods of measuring cation-exchange capacities of 13 samples of cotton cellulose phosphorylated in various ways are discussed, and conclusions are summarized in a table. Some preliminary work was done on samples phosphorylated with phosphorus oxychloride and pyridine. It was found, however, that better results could be obtained with phosphoric acid and urea. Cotton cellulose treated by this method has a high-cation-exchange capacity and, when used in the form of a coarse fabric, shows good flow characteristics in the calcium-hydrogen cycle. Its cation-exchange capacity increases with the phosphorus content and reaches about 1,000 milliequivalents per kg. when about 5 percent of phosphorus is present.

310. **TRIMETHYLSILYLCELLULOSE.** Schuyten, H. A.; Weaver, J. W.; Reid, J. D.; and Jurgens, J. F. J. Am. Chem. Soc. *70:* 1919–20. 1948.

A study is described that indicates the formation of definite compounds of cellulose with substituted silanes. The reaction of trimethylchlorosilane and other chloro- and acetoxysilanes with cellulose gave products that, by gain in weight and silicon content, showed a group substitution as high as 2.75 groups per glucose unit. When the change in weight was determined over a period of time it was evident that the trimethylsilylcellulose thus formed is stable in dry air at room temperature but decomposes slowly at elevated temperatures or in the presence of atmospheric moisture. It may be readily hydrolyzed with boiling water or with dilute acids or alkalies, but it is insoluble in the usual organic solvents and in mixtures of solvents such as are used in dissolving cellulose acetate and other cellulose derivatives.

275. STABILIZATION OF CELLULOSE NITRATE WITH AMMONIA. Reeves, R. E.; and Giddens, J. E. Ind. Eng. Chem. *39:* 1303–6. 1947.

The marked stabilization of unstable propellant-type cellulose nitrate caused by treatment with ammonium hydroxide and faintly acid solutions of ammonium salts is described. The corresponding effect was not obtained with a number of common metallic hydroxides, salts, and amines. With dilute solutions of ammonium hydroxide, the stabilization was produced almost instantaneously at room temperature. Stability was measured by tests carried out at 110° and 134.5° C. The ammonia-induced stability may be reversed by suitable treatment with mineral acids, but subsequent treatment with ammonia again produces stability. Cellulose nitrate that has been stabilized by long boiling and beating treatments is not further stabilized by ammonia treatment.

269. INTRODUCTION OF AMINO GROUPS INTO COTTON FABRIC BY USE OF 2-AMINOETHYLSULFURIC ACID. Guthrie, J. D. Textile Research J. *17:* 625–29. 1947.

It has been found that enough amino groups may be introduced into cotton fabrics to give a dark dyeing with acid wool dye by treatment with 2-aminoethylsulfuric acid. The best results are obtained when the fabric is moistened with a 10-percent solution of this compound containing 25 percent of sodium hydroxide, heated for 40 minutes at 100° C. in a drying oven, and thoroughly washed. The nitrogen content of fabric so treated is about 0.56 percent of the dry weight. Other properties of the aminized fabric, besides its dyeing with acid dyes, are described in detail. A method of introducing amino groups into cotton fabrics by use of the less economical 2-chloroethyl-amine is also given.

277. THE PARTIAL CARBOXYMETHYLATION OF COTTON TO OBTAIN SWELLABLE FIBERS. I. Reid, J. D.; and Daul, G. C. Textile Research J. *17:* 554–61. 1947.

To obtain quickly swellable fibers, as aid in making cloth less pervious to water, cotton has been partially carboxymethylated by the impregnation of cellulose with a solution of monochloracetic acid and treated with a strong solution of sodium hydroxide. Degree of substitution may be varied by changes in experimental conditions. With substitution of about 1 acid group per 15 glucose residues or less, the treated cotton does not vary greatly from mercerized controls in breaking strength, feel, appearance, or moisture content; but swelling capacity and water retention are greatly increased. Although the addition of small amounts of carboxymethyl group to the cellulose molecule does not protect it from microbiological attack, addition of copper, silver, or mercury to form the corresponding insoluble salt of carboxymethylcellulose imparts considerable resistance to such attack.

271. PILOT-PLANT BLEACHING OF COTTON FABRICS. Kettering, J. H.; and Berard, W. N. Am. Dyestuff Reptr. *36:* 552–54. 1947.

A satisfactory pilot-plant method of bleaching 100- to 200-pound lots of fabrics has been developed as part of a broad program of research on the bleaching of cotton fabrics. Formulas, liquor ratios, temperatures, description of the apparatus, and other details of the procedure are given. The results of physical and chemical analyses showed that the two types of cotton fabric investigated by the method, when judged by breaking strength and fluidity in cuprammonium hydroxide, met present commercial standards.

270. COMMERCIAL COTTON-BLEACHING PROCESSES AND THEIR EFFECT ON FABRICS. Kettering, J. H., and Kraemer, R. M. U.S. Dept. Agr. Tech. Bul. 941, 37 pp. 1947.

Eleven bleaching processes were investigated representing three general classes of modern commercial bleaching methods: (1) Caustic soda kier boil and hypochlorite bleach; (2) caustic soda kier boil and hydrogen peroxide kier bleach; and (3) continuous bleaching. The caustic soda kier boil and hypochlorite bleach yielded fabrics with lower amounts of residual impurities (alcohol-soluble materials, wax, and ash) and with higher cellulose content than the fabrics from either of the other two classes. Fabrics continuously bleached showed slightly lower amounts of residual impurities, with slightly higher cellulose content, than fabrics from the caustic soda kier boil and hydrogen peroxide kier bleach. When measured by fabric changes (breaking strengths, thicknesses, weights, and fluidities), the caustic soda kier boil and peroxide kier bleach showed slightly better results than the continuous bleach using hydrogen peroxide; and both of these gave better results than the caustic soda kier boil and hypochlorite bleach. The one process using chlorite produced a slightly excessive degradation as measured by fluidities in cuprammonium hydroxide, but this observation is the result of a single processing and indicates only that careful control is imperative when chlorite is used for bleaching purposes. As judged by reflectance measurements, no differences were revealed in the three classes of processes. The slight fluctuations in the recorded values were within the limits of precision of the measurements and too small for sure visual detection. Absorbability determinations revealed no differences between the three bleaching classes. Although each of the three classes of bleaching processes had some disadvantages, all were satisfactory and produced fabrics of good commercial quality.

238. MICROSCOPICAL METHODS IN THE MEASUREMENTS OF SWELLING IN COTTON FIBERS: A LITERATURE SURVEY. Rollins, M. L. Textile Research J. *17:* 19–26. 1947. Republished—Textile J. of Australia *22*: 520–22, 592–94, 676, 678. 1947.

The literature on the microscopical measurement of cotton contains little useful information on the swelling of fibers. Virtually no work is reported on such measurement of raw cotton fibers swelled in water. The majority of studies were made on fibers that had been mercerized or purified by boiling in sodium carbonate; or they had to do with the swelling of dry fibers upon immersion in a solution of one of the alkali metal hydroxides. Few of the results reported are comparable because of the variations in the pretreatments used by the different workers. Furthermore, because the figures in many cases are based on a few dozen fibers, the natural variability of cotton samples is not sufficiently taken into account. For statistical accuracy, several hundred samples should be tested. While estimation of the change in area of the cross section calculated from the ribbon width of the fiber has been accepted as a measure of swelling, it would seem that the degree of circularity (or ratio of width to thickness), as measured by Barritt and Pope, is a better index of the amount of change induced by absorption of water, because the degree of circularity indicates the extent to which the fiber has returned to its original shape in the living boll. Further investigation of swelling by microscopical methods appears justified.

241. **THE SWELLING OF COTTON AND UTILIZATION OF SWELLING IN WATER-RESISTANT FABRICS.** Goldthwait, C. F. Chemical Research Conferences, AAAS (Textiles) July 10, 1947. New London, N. H.

Problems in developing fabrics that resist the passage of water by a self-sealing effect, and particularly work along this line at the Southern Regional Research Laboratory, are discussed, beginning with the production of unlined cotton firehose. Swelling is defined, and the orifice test for comparing swelling of fibers in yarn form by measuring seepage is described. Production of experimental swelling-type fabrics and the effects of finishing treatments are discussed; and the conclusion is drawn that such treatments detract from the initial self-sealing capacity of such fabrics. Results in general show that thin-walled, flat cotton fibers have more closing effect when wet than do thick-walled, rounder, more mature fibers, and indicate that something other than swelling is a factor in closing capacity. Results also indicate that the use of added insoluble but swellable materials may improve self-sealing effects.

276. **MECHANISM OF AMMONIA STABILIZATION OF CELLULOSE NITRATE.** Reeves, R. E.; and Giddens, J. E. Ind. Eng. Chem. *39:* 1306–9. 1947.

Pyro-type cellulose nitrate purified in the conventional manner, when judged by heat tests only, does not possess adequate stability unless sulfate content has been reduced to an extremely low value; but nitrate still containing appreciable amounts of sulfate can be treated with cold, dilute, aqueous ammonia so as to markedly increase stability without removing the sulfate. The stabilization appears to be the result of neutralization of the sulfuric acid trapped within the fibrous cellulose nitrate. In freshly prepared cellulose nitrate that has been thoroughly rinsed but not boiled, the sulfate is apparently retained in the form of cellulose acid sulfate. After ammonia treatment, this material retains approximately 1 mole of ammonia per mole of sulfate. After a brief boil, there is some evidence indicating that the trapped acid may be partly in the form of free sulfuric acid. Undissociated ammonia and not ammonium ion brings about the stabilization. Apparently ammonium ion, as well as the ions of many other bases, is unable to penetrate the fiber.

213. **THE ALCOHOLYSIS OF CELLULOSE.** Reeves, R. E.; Schwartz, W. M.; and Giddens, J. E. J. Am. Chem. Soc. *68:* 1383–84. 1946.

Alcoholysis of cotton fibers or cotton linters was carried out with 0.5 *N* hydrochloric acid in methanol, ethanol, 9:1 methanol-water (by volume), and water, for various periods of time at 20° C. The recovery of fiber was more than 95 percent in all instances. The rate of degradation was greatest for absolute methanol and least for water. Alcoholysis did not produce an increase in the copper number of the cellulosic material. The limiting values for the fluidity upon methanolysis appeared to be approximately 60 rhes for native cellulose and 70 rhes for mercerized cellulose. Methanolysis of native cotton linters yielded a product with approximately 0.58-percent methoxyl and of mercerized linters a product with 0.87-percent methoxyl. Long-continued extraction with water did not remove methoxyl from the cellulose, but hydrolysis for 24 hours with 0.5 *N* hydrochloric acid reduced the methoxyl from 0.54 to 0.25 percent and increased the copper number from 0.24 to 8.6. Methanolyzed cotton fiber contains 2.4-percent alkali-soluble material, whereas hydrolyzed material of the same fluidity contains 45.6-percent alkali-soluble material.

185. **EVALUATION AND COMPARISON OF TWO COMMERCIAL BLEACHING PROCESSES.** Kettering, J. H., and Kraemer, R. M. Am. Dyestuff Reptr. *35:* 285–87. 1946.

Samples of identical broadcloths processed by a double-boil hydrogen peroxide-bleach method and by a single-boil hypochlorite bleach were not essentially different in their properties. Visual inspection and the usual control tests applied in the bleacheries did not reveal any differences. Fluidities in cuprammonium hydroxides were the only analytical values that varied significantly; the double-boil hydrogen peroxide process was favored only slightly. The data suggest that some shortening of the kier boiling time in the conventional kier boil-hypochlorite bleach process would in some respects enhance the quality of output without sacrificing any valuable property.

177. **DETERMINATION OF SMALL AMOUNTS OF SOAPS OR FATTY ACIDS ON COTTON MATERIALS.** Hoffpauir, C. L.; and Kettering, J. H. Am. Dyestuff Reptr. *35:* 265–66. 1946.

The method described offers procedures for determining 100 milligrams or less of fatty acids or their soaps on comparatively large samples (5 to 15 grams) of cotton fibers, yarns, or fabrics. The acids and their soaps are removed by Soxhlet extraction with ethyl or isopropyl alcohol, separated from extraneous material by extraction with low-boiling petroleum ether after acidification with hydrochloric acid, and finally titrated with alcoholic sodium hydroxide in the absence of carbon dioxide by use of meta-cresol purple indicator. The accuracy of the method is demonstrated by recovery data.

187. **DECREASING THE ACID DEGRADATION OF COTTON SEWING THREAD.** Reid, J. D.; Mazzeno, L. W.; and Ward, Kyle, Jr. Textile Research J. *16:* 26–31. 1946.

A special phase of the acid hydrolysis that occurs in the cotton sewing thread used to close multi-wall paper bags for shipment of triple superphosphate was investigated. An accelerated aging test was developed and a method devised that decreased the loss of thread strength. Acid fumes caused most of the degradation. The use of alkaline sizing agents, or protective coatings such as soap or beeswax, is comparatively inefficient, as is the use of carbonates in the fertilizer to neutralize the acid. A mildly alkaline humectant agent such as triethanolamine, impregnated into the thread in amounts of about 35 percent, gives good protection in accelerated trials both in laboratory tests and in use-tests involving 80-day storage.

137. **THE WATER REPELLENCY OF TEXTILE FABRICS.** Wakeham, Helmut; Strickland, W. B.; and Skau, E. L. Am. Dyestuff Reptr. *34:* 178–82. 1945.

Some theoretical aspects of water repellency in treated fabrics are reviewed. The significance of contact angle and size of openings in such fabrics is pointed out. Evaluation of water-repellent fabrics should include measurements of contact angle, spray-test rating, air permeability, and resistance to hydrostatic pressure. A new tensiometric test for surface wettability is presented and is compared with the usual tests.

129. **WATER-TIGHT FABRICS MADE BY SWELLING COTTON FIBERS.** Goldthwait, C. F.; and Smith, H. O. Textile World *97* (7): 105, 107, 196, 198. 1945.

A new method for making a water-holding cotton firehose without the use of rubber lining involves the addition to the yarn before weaving of a swellable finishing material not soluble in water, to supplement the swelling of the cotton and thus to produce a self-sealing fabric. A commercial hydroxyl ethyl ether of cellulose was used as the swellable agent. The method appears applicable to any cloth construction intended to utilize the principle of swelling.

54. **WATER VAPOR PERMEABILITY OF CERTAIN COATED FABRICS.** Stearn, J. T.; and Cooper, A. S., Jr. Am. Dyestuff Reptr. *33:* 150–56. 1944.

Effects of various coatings on the water-vapor permeability of fabric and on resistance to the passage of liquid water were studied. It was found that cotton broadcloth could be given a coating that would withstand the 50-cm. hydrostatic pressure AATCC test with comparatively slight reduction in permeability to water vapor, and results indicated that several synthetic resins and cellulose derivatives should be satisfactory for the purpose if not compounded to make them too highly water-resistant. As an aid in the tests, the permeability cup test was modified so as not to require highly specialized equipment or an undue amount of the operator's time.

41. **STABILIZATION OF OXIDIZED COTTON FIBER.** Reeves, R. E. Ind. Eng. Chem. *35:* 1281. 1943.

Damage to cotton fiber upon oxidation by periodic acid does not become fully apparent as loss of tensile-strength until the oxidized fiber has been exposed to alkalies. If the oxidation is followed by treatment with ethereal diazomethane or sodium chloride at pH 4, the total loss of strength after subsequent exposure to alkali may be greatly decreased through the lessening of the secondary deterioration of the fiber after oxidation. While acting to diminish alkali deterioration of oxidized cotton fiber, these treatments also increase the cuprammonium viscosity of the oxidized fiber and decrease its alkali solubility. The beneficial action of these reagents is believed to be due to the stabilization of weakened positions within the cotton fiber and not to an actual reversal degradation.

Related Chemical Investigations

1755. **REACTION OF EPICHLOROHYDRIN WITH CYCLOHEXYLAMINE.** McKelvey, J. B.; Webre, B. G.; and Klein, Elias. J. Org. Chem. *24:* 614–16, 1959.

The addition of epichlorohydrin to cyclohexylamine through the epoxide group has been reinvested. Two chlorohydrins, N-(3-chloro-2-hydroxypropyl)cyclohexylamine and N,N-bis(3-chloro-2-hydroxypropyl)cyclohexylamine, have been isolated. These compounds have been converted to their respective epoxides and hydrochlorides.

1588. **THE SIMULTANEOUS MEASUREMENT OF DISTRIBUTION COEFFICIENTS AND HYDROLYSIS RATES.** Klein, Elias; McKelvey, J. B.; and Webre, B. G. J. Phys. Chem. *62:* 286–88. 1958.

When butadienediepoxide is reacted with cotton cellulose in the presence of aqueous sodium hydroxide, a three-phase reaction system is involved. Two of the important parameters are the distribution of the reagent between the organic and aqueous phases and the rate of hydrolysis of the reagent in the latter. Consequently, a technique that would allow the measurement of the distribution coefficient and the hydrolysis rate as a function of base strength was highly desirable.

1056. **CUPRAMMONIUM-GLYCOSIDE COMPLEXES. VII. GLUCOPYRANOSIDE RING CONFORMATIONS IN AMYLOSE.** Reeves, R. E. J. Am. Soc. *76:* 4595–98. 1954.

The gels that form when amylose is placed directly in cuprammonium, or when a neutral amylose solution is precipitated, contain about 0.5 to 0.6 mole of copper per mole of glucose anhydride. This low copper-to-glucose combining ratio, the limited solubility in cuprammonium, and the measurements of specific rotations for amylose (and, for comparison, for methyl-*β*-maltoside, methyl-*α*-glucoside) and methyl-*β*-cellobioside in aqueous sodium hydroxide solutions, along with other considerations—all point to the conclusions that amylose contains more than one ring conformation, evidence pointing toward two boat-form rings; but that alkali-amylose contains only one ring form, tentatively held to be a boat-form.

1037. **THE COMPOSITION OF SOME TETRA-*t*-BUTYL TITANATE-GLYCOL REACTION PRODUCTS.** Reeves, R. E.; and Mazzeno, L. W., Jr. J. Am. Chem. Soc. *76:* 2533–36. 1954.

Accurate cryoscopic measurements can be made with tetra-*t*-butyl titanate (T*t*BT) in highly purified *t*-butyl alcohol. Such measurements on solutions of T*t*BT with ethylene glycol, octylene glycol, or butanediol indicate the formation of molecular aggregates considerably larger than would occur if T*t*BT combined with one or two moles of glycol. Evidence is presented that strongly indicates the formation of a compound having the titanate:glycol ratio of 2:3; the species formed may actually contain 4 moles of titanate and 6 of glycol. The formation of other compounds having the compositions 2:2, 2:4, and 3:6 is also suggested. Thus it appears that T*t*BT does not form simple chelates with one or two bidentate glycol residues attached to a central titanium atom. On the other hand, T*t*BT appears to react with ethyl acetoacetate to form 1:1 and 1:2 compounds. The present observations are discussed in relation to certain structural proposals that have appeared in the literature.

1036. **THE REARRANGEMENT OF ACETYLATED AND BENZOYLATED *BETA*-GLUCOSIDES CATALYZED BY TITANIUM TETRACHLORIDE.** Reeves, R. E.; and Mazzeno, L. W., Jr. J. Am. Chem. Soc. *76:* 2219–21. 1954.

Titanium tetrachloride catalyzes the formation of an equilibrium mixture of benzoylated nonaromatic glucosides in which the alpha-isomer greatly predominates over the beta-isomer. The reaction provides a convenient method of preparing the alpha-glucosides from their anomers. The transformation of benzoylated beta-glucosides occurs more readily than that of the corresponding acetates. Application of the isorotation rules has indicated that when benzoates are compared with their corresponding acetates, benzoylation is found to have increased the dextrorotation of the C_2-C_6 portion of glucoside molecules and to have decreased the influence of the aglucone on the rotation. Six new crystalline glucoside derivatives and a crystalline compound containing *o*-nitrophenol, titanium, and chlorine in the ratio 2:1:2 have been prepared.

976. **SULFATOALKYL AMINES.** Reeves, W. A.; and Guthrie, J. D. J. Am. Chem. Soc. *75:* 4101. 1953.

Preparation of seven sulfatoalkyl amines is described and the compounds are characterized. A typical preparation is described in detail.

845. **EVIDENCE FOR INTERACTION BETWEEN CHLOROFORM AND MONOETHYLAMINE.** Segal. Leon: and Jonassen, H. B. J. Am. Chem. Soc. *74:* 3697–99. 1952.

The difficulty of separating anhydrous monoethylamine (bp 17° C.) from chloroform (bp 60°) by distillation or extraction with water suggested that some sort of interaction was present between the two compounds. Mixing the two liquids, both at 5°, caused a temperature rise of 23°; no rise was observed by mixing ethylamine and hexane. The boiling point diagram for monoethylamine and chloroform showed considerable deviation from Raoult's Law; the amine and hexane distilled normally. Diethylamine and chloroform formed an azeotrope (bp 68°, mole fraction of chloroform 0.57). Refractive index measurements of the monoethylamine-chloroform and diethylamine-chloroform systems showed a break at mole fraction of chloroform 0.5 for the former and none for the latter. Extraction with water only slowly affected the amine concentration in the ethylamine-chloroform system, but rapidly reduced it in the amine-hexane system.

697. **GLUCONIC ACID FROM HYPOIODITE OXIDIZED HYDROCELLULOSE.** Blair, M. G., and Reeves, R. E. J. Am. Chem. Soc. *74:* 2608–9. 1952.

Hypoiodite-oxidized hydrocellulose was subjected to methanolysis; the residual hydrochloric acid was neutralized by diazomethane; and most of the glucosides were removed by direct crystallization. The oxidized residue thus concentrated was isolated as D-gluconic phenylhydrazide and as D-gluconic amide and the methylamide. Of the carboxyl indicated by analytical methods to be in the original oxycellulose, 21 percent was accounted for by isolation from the alcoholysate; most of the remainder was found in the insoluble residue from the methanolysis where it existed in an unesterified form, either as free acid or as lactone. D-gluconic methylamide was prepared in 95-percent yield by the reaction of the gamma-lactone in a cold methanolic solution of methylamine. Analyses and the higher melting point indicate that the preparation has greater purity than that previously described by van Wijk.

619. **ETHYLENIMINE BY FLASH DISTILLATION.** Reeves, W. A.; Drake, G. L., Jr.; and Hoffpauir, C. L. J. Am. Chem. Soc. *73:* 3522. 1951.

A process for preparing ethylenimine based on the flash distillation of a solution consisting of 2-aminoethyl hydrogen sulfate and sodium hydroxide is described. The yield obtained was 83 percent.

668. **STEARAMIDOMETHYL ETHERS.** Weaver, J. W.; Schuyten, H. A.; Frick, J. G., Jr.; Reid, J. D. J. Org. Chem. *16:* 1111–16. 1951.

The stearamidomethyl ethers of methanol ethanol, propanol-2, n-butanol, octanol, and phenol have been prepared and characterized. The ethyl, isopropyl, butyl, and phenyl derivatives are new compounds. This study shows that their properties do not resemble the ethers but rather resemble those of acetals, as would be predicted.

621. **FUCHSIN-SULFITE REAGENT IN COLORIMETRIC DETERMINATION OF FORMALDEHYDE.** Segal, Leon. Anal. Chem. *23:* 1499. 1951.

This study shows that Schiff's reagent used in the colorimetric formaldehyde determination, as developed by Hoffpauir, Buckaloo, and Guthrie (Ind. Eng. Chem. Anal. Ed. 15: 605 (1943)), may be decolorized with beneficial and no adverse effects by use of certain decolorizing carbons.

539. **THE REACTION BETWEEN METHANOL AND HYDROGEN CHLORIDE AT 0° C.** Reeves, R. E.; Hoffpauir, C. L.; and Demint, R. J. Textile Research J. *21:* 81–82. 1951.

Contrary to a report in the literature, it is shown that the reaction between methanol and hydrogen chloride proceeds at an appreciable rate at 0° C.

538. **CUPRAMMONIUM-GLYCOSIDE COMPLEXES. VI. THE D-MANNOSAN COMPLEX.** Reeves, R. E. J. Am. Chem. Soc. *73:* 957–59. 1951.

Complex formation between cuprammonium and D-mannosan produced a visible color change and increased absorption of light in the near ultraviolet, a shift in optical rotation, and a decrease in the conductance of a dilute cuprammonium solution. Measurements at equilibrium conditions by four techniques indicate a single stoichiometric reaction involving one molecule of D-mannosan and one of cuprammonium. This mechanism is shown to be considerably simpler than the one attributed to the reaction between cellulose and cuprammonium. The reaction constant for formation of the cuprammonium-D-mannosan complex is approximately 2.5×10^3 at 25° with the cuprammonium employed in the present work.

465. **TETRABENZOYL-α-D-GLUCOPYRANOSYL BROMIDE-CARBON TETRACHLORIDE ADDITION COMPOUND.** Mazzeno, L. W., Jr. J. Am. Chem. Soc. *72:* 1039. 1950.

The preparation of the addition compound of tetrabenzoyl-α-D-glucopyranosyl bromide-carbon tetrachloride is described, and analytical data (calculated and found) are presented.

442. **THE SHAPE OF PYRANOSIDE RINGS.** Reeves, R. E. J. Am. Chem. Soc. *72:* 1499–1506. 1950.

Consideration of 52 glycopyranosides from the point of view of ring shape in solution showed that pyranose rings assumed a chair form in preference to any boat form wherever both were structurally possible. Any substituent (other than hydrogen) oriented perpendicular to the pyranose ring introduced an element of instability into the conformation. Especially important were an erected oxygen on position 2 when its C-O valence bisected the two C-O valences on carbon atom 1 and a carbinol group at position 5 erected on the same side of the ring with a hydroxyl or substituted hydroxyl group. Conformational instability was observed for the methyl pyranosides of α- and β-altrose, α- and β-lyxose, and β-idose. These glycosides probably exist in solution in an equilibrium composed of appreciable amounts of both chair conformations. The formation of $<1,5>\beta$ $<1,6>$ anhydrides in aqueous acid and the composition of the equilibrium solution of reducing sugars were related to the factors that influenced conformational stability. Conformational instability factors are listed for all the D-aldohexoses and D-aldopentoses. Methyl β-D-altropyranoside and methyl 2-methyl-α-D-idopyranoside were prepared and characterized.

401. **DETERMINATION OF GLYCOSIDIC METHOXYL.** Hoffpauir, C. L.; and Reeves, R. E. Anal. Chem. *21:* 815–17. 1949.

A method for determining small amounts of glycosidic methoxyl, based on the hydrolysis of methyl glycosides by strong sulfuric acid to yield methanol, is described. The methanol is isolated and oxidized to formaldehyde, which is then determined colorimetrically by use of a sensitive fuchsin-sulfurous acid reagent. If large amounts of ether-linked methoxyl are present, as in the case of highly methylated cellulose derivatives, the yield of methoxyl is plotted against time and extrapolated to zero to obtain the values for glycosidic methoxyl.

374. DIRECT TITRATION OF *CIS* GLYCOLS WITH LEAD TETRA-ACETATE. Reeves, R. E. Anal. Chem. *21:* 751. 1949.

Neighboring hydroxyl groups oriented in the true *cis* position react with lead tetra-acetate so rapidly that they may be determined by direct potentiometric titration employing lead and platinum electrodes.

427. 2,3-BENZYLIDENE-1,4-ANHYDRO-D-MANNITOL. A CASE OF BENZYLIDENE MIGRATION. Reeves, R. E. J. Am. Chem. Soc. *71:* 2868–70. 1949.

A new anhydro-D-mannitol derivative, 2,3-benzylidene-1,4-anhydro-D-mannitol is described, and doubt is cast on the structures 5,6-benzylidene-1,4-anhydro-D-mannitol and 2,3-dibenzoyl-5,6-benzylidene-1,4-anhydro-D-mannitol previously assigned to two other substances.

373. CUPRAMMONIUM-GLYCOSIDE COMPLEXES. V. THE CONFORMATION OF THE PYRANOSE RING IN SOME D-HEXOSE $<1,5>\beta<1,6>$ ANHYDRIDES. Reeves, R. E. J. Am. Chem. Soc. *71:* 2116–19. 1949.

It is observed that only two of the eight Sachse strainless pyranose ring conformations meet the steric requirements of the hexose $<1,5>\beta<1,6>$ anhydrides (the levoglucosan type of anhydrides). Furthermore, only one of these two conformations would result in the behavior observed for five D-hexosans, four monomethyl-D-hexosans, and one monobenzyl-D-hexosan. Therefore, a definite assignment of conformation can be made for the pyranose ring in this group of substances. The ring must exist in the chair form 1C, the one in which the ring oxygen atom and carbon atom 6 project on opposite sides of the plane of carbon atoms 1,2,4,5. Methyl 3-methyl-β-D-idoside, 2,4-dibenzyl-3-methyl-D-glucosan $<1,5>\beta<1,6>$, and 4-methyl-D-mannosan $<1,5>\beta<1,6>$ were prepared in the form of sirups and were characterized by means of optical rotations. 3-Methyl-D-glucosan $<1,5>\beta<1,6>$, 2-methyl-D-galactosan $<1,5>\beta<1,6>$, 4-benzyl-D-mannosan $<1,5>\beta<1,6>$, 3-methyl-D-idosan $<1,5>\beta<1,6>$ were prepared in crystalline form.

372. CUPRAMMONIUM-GLYCOSIDE COMPLEXES. IV. THE CONFORMATION OF THE GALACTOPYRANOSIDE RING IN SOLUTION. Reeves, R. E. J. Am. Chem. Soc. *71:* 1737–39. 1949.

Nineteen substances belonging or related to the galactopyranosides were investigated in cuprammonium solution. It was observed that the behavior of D-galactopyranosides and L-arabopyranosides is compatible with ring confirmation Cl, L-fucosides and D-arabinopyranosides with the mirror image conformation, 1C. The pyranose ring of D-galactosan $<1,5>\beta<1,6>$ exists in the 1C conformation; thus the ring shape of the anhydride is different from that of the methyl and phenyl D-galactopyranosides.

371. CUPRAMMONIUM-GLYCOSIDE COMPLEXES. III. THE CONFORMATION OF THE D-GLUCOPYRANOSIDE RING IN SOLUTION. Reeves, R. E. J. Am. Chem. Soc. *71:* 215–17. 1949.

Consideration of the properties of 17 D-glucopyranoside derivatives has led to the conclusion that, in this series, complex formation between cuprammonium and two hydroxyl groups occurs only with the glycol on the second and third or third and fourth carbon atoms. Consideration of the behavior of 12 complex-forming glucosides in light of a previously presented theory reduces from 8 to not more than 3 the number of conformations that need be considered to represent the shape of the pyranoside ring of each glucoside in solution; for 3 of the substances, only 1 ring conformation appears to be possible. A single-ring conformation, the *trans* "chair form" in which the ring oxygen and 6-carbon atom project on the same side of the plane of the 1,2,4,5-carbon atoms, is sufficient to explain the behavior of all the complex forming glucosides in solution.

370. CUPRAMMONIUM-GLYCOSIDE COMPLEXES. II. THE ANGLE BETWEEN HYDROXYL GROUPS ON ADJACENT CARBON ATOMS. Reeves, R. E. J. Am. Chem. Soc. *71:* 212–14. 1949.

The position is taken that complex formation between cuprammonium and two hydroxyl groups occurs most readily when the hydroxyl groups are located at a particular distance apart. Examination of cellulose and a number of other substances having hydroxyl groups on adjacent carbon atoms held more or less rigidly at a number of angles (hence distances) has shown complex formation to occur readily at the true *cis*-position (0-degree angle) and the 60-degree angle, but not at the 120-degree or the 180-degree angle.

369. CUPRAMMONIUM-GLYCOSIDE COMPLEXES. I. CONDUCTOMETRIC MEASUREMENTS. Reeves, R. E.; and Jung, J. R., Jr. J. Am. Chem. Soc. *71:* 209–11. 1949.

A conductometric method is described that is capable of measuring the relative affinities of various substances for cuprammonium. Differences in affinity were observed for the optically active and *meso* forms of 2,3-butanediol. Differences were noted in the behavior of various methyl α-hexosides, and between various α- and β-pyranoside pairs. The substance D-glucosan $<1,5>\beta<1,6>$ was shown to react with cuprammonium solution.

367. SENSITIZATION OF FUCHSIN-SULFUROUS ACID REAGENT FOR FORMALDEHYDE BY ADDITION OF KETONES. Hoffpauir, C. L.; and O'Connor, R. T. Anal. Chem. *21:* 420. 1949.

In efforts to increase the sensitivity of fuchsin-sulfurous acid reagent to small quantities of formaldehyde, the authors observed that acetone caused a more intense and stable color in the reaction, with no shift in the wave length of maximum absorption and no change in the nature of the spectrophotometric curve in the visible spectrum. The curve of percent transmittance vs. concentration in the presence of acetone differed only in intensity of absorption from that obtained without acetone. Similar, but no better, effects were noted for methyl *n*-propyl ketone, diethyl ketone, diacetone alcohol, and methyl ethyl ketone. Ethylene glycol was found to intensify the color slightly. Fructose, a ketose, had no effect.

359. PHENYL β-D-GALACTOPYRANOSIDE DERIVATIVES. Reeves, R. E. J. Am. Chem. Soc. *70:* 3963–64. 1948.

The procedure by which each of the following compounds was prepared from phenyl β-D-galactopyranoside is described: Phenyl 4,7-benzylidene-β-D-galactoside; phenyl 2,3-diacetyl-4,6-benzylidene-β-D-galactoside; phenyl 2,3-dimethyl-4,6-benzylidene-β-D-galactoside; phenyl 2,3-dimethyl-β-D-galactopyranoside; phenyl 2,3-di-N-phenylcarbamyl-4,6-benzylidene-β-D-galactoside; phenyl 2,3-dibenzyl-4,6-benzylidene-β-D-galactoside; and phenyl 2,3-dibenzyl-β-D-galactopyranoside. The phenyl β-D-galactopyranoside used in the experiments was prepared by catalytic deacetylation with sodium methylate of carefully purified tetra-acetate.

325. METHYL 2,6-DIMETHYL-ALPHA-D-GLUCOPYRANOSIDE. Reeves, R. E. J. Am. Chem. Soc. *70:* 259–60. 1948.

Because of the need for an alkali-stable glucopyranoside substituted in positions 2 and 6, methyl 2,6-dimethyl-alpha-D-glucopyranoside has been synthesized by two different methods. Its optical rotations in water and in cuprammonium hydroxide solution are given.

294. **CUPRAMMONIUM-2,3-BUTANEDIOL COMPLEXES.** Reeves, R. E. J. Am. Chem. Soc. *69:* 1836. 1947.

The behavior of the optically active 2,3-butanediols in cuprammonium hydroxide solution is noted in a "Letter to the Editor." The specific rotations measured at 25° C. for the D–(−)– and L (+)– forms of the two butanediols in water and in cuprammonium are tabulated.

278. **PREPARATION OF SUBSTITUTED ACETOXY SILANES.** Schuyten, H. A.; Weaver, J. W.; and Reid, J. D. J. Am. Chem. Soc. *69:* 2110–12. 1947.

Silicon tetra-acetate and substituted acetoxysilanes have been prepared from the corresponding chlorides and anhydrous sodium acetate in an anhydrous solvent. The physical properties of some substituted acetoxysilanes are recorded. Seven of the compounds reported are new.

176. **UPTAKE OF HYDROCHLORIC ACID BY COTTONSEED AND COTTON FIBER DURING "FUMING" OF ANALYTICAL SAMPLES.** Faust, A. F.; and Henson, F. A. Oil and Soap *23:* 74. 1946.

Ten-gram samples of cottonseed with various percentages of linters, as well as 10-gram samples of cottonseed hulls and meats, raw and purified cotton fibers, and purified cotton linters, were burned in 2-gram portions in a Parr oxygen bomb. Chlorine was determined gravimetrically as silver chloride. The results are tabulated and show that cottonseed takes up 0.4- to 0.5-percent total chlorine and that all parts of the seed are capable of taking up hydrochloric acid. The effect of this is to lower the percentage of oil about 0.1 percent and the total nitrogen by about 0.02 percent.

70. **THE OPTICAL ACTIVITY OF THE COPPER COMPLEXES OF POLYSACCHARIDES AND SUBSTITUTED METHYL GLUCOSIDES.** Reeves, R. E. J. Biol. Chem. *154:* 49–55. 1944.

It has been found that the four possible monomethyl β-methylgluco-pyranosides show widely different optical behavior when dissolved in cuprammonium hydroxide solution. The optical activity of methyl 2-methyl-β-glucoside in water and cuprammonium so closely resembles that of the polysaccharide from *Phytomonas tumefaciens* that it is suggested that this polysaccharide is composed of glucopyranose units linked chiefly through the 2 position. The optical behavior of a 3-linked polysaccharide and several 4-linked polysaccharides is similar to that of the correspondingly substituted methyl glucosides. The shift in the optical rotation of glucopyranoside polysaccharides upon being dissolved in cuprammonium hydroxide solution may be used to classify glucose polysaccharides and may in certain instances furnish information regarding the structure of the polysaccharide.

55. **METHYL 3-METHYL-4,6-ETHYLIDENE-ALPHA- AND BETA-GLUCOSIDES.** Reeves, R. E. J. Am. Chem. Soc. *66:* 845. 1944.

Preparation of the alpha- and beta-methylglucosides from noncrystalline triacetate is described. Steps in the preparation of the compounds and their analytical data and optical rotation are given.

39. **DETERMINATION OF COMBINED FORMALDEHYDE IN ORGANIC COMPOUNDS AND IN CELLULOSE FORMALS.** Hoffpauir, C. L.; Buckaloo, G. W.; and Guthrie, J. D. Ind. Eng. Chem. Anal. Ed. *15:* 605–6. 1943.

Standard methods for determining formaldehyde usually require distillation with acid in order to isolate the formaldehyde. In the method presented, distillation is omitted and the formaldehyde is determined in the hydrolysate by a procedure adapted to a photoelectric colorimeter in which a magenta color is developed by use of Schiff's reagent. Correct results may be obtained even in the presence of considerable amounts of other aldehydes. The procedure is applicable to organic formals and because of its sensitivity can be used on samples containing very small amounts of formaldehyde.

MECHANICAL PROCESSING

Machinery

1839. **SRRL GRANULAR CARD—INSTALLATION MANUAL.** Miller, A. L.; Brown, R. S.; and Rusca, R. A. U.S. Dept. Agr. ARS 72–16, 9 pp. 1959.

The SRRL Granular Card, developed at the Southern Utilization Research and Development Division, is a mechanism for converting revolving flat cotton cards to carding without flats, thereby eliminating all flat waste. On an average, overall card waste is reduced about 50 percent, and this amounts to a saving of 2 to 3 percent of the total cotton processed. At the same time, neps are reduced slightly. Lower processing costs and improved quality of the textile products should increase the utilization of cotton. The carding apparatus is simple insofar as number of parts and intricacy of mechanisms are concerned; however, the importance of dimensional trueness in manufacture and exactness in erection cannot be overemphasized. The engineering drawings issued by the Department of Agriculture show the dimensional tolerances that cannot be exceeded except at the risk of lowering the performance of the machine. Proper erection of the apparatus, whether by the manufacturer or the mill, is equally important; and it is for this reason that this illustrated publication of a recommended procedure is issued.

1804. **AIR-BRUSH DOFFER.** Mayer, M., Jr.; and Kotter, J. I. Textile Ind. *123* (8) : 123–24. 1959.

Research on the development of a cleaning attachment for the SRRL Cotton Opener has led to a new type doffer for removing the cotton from the processing cylinders of the machine. Designed and used as an integral part of the cleaning attachment, this efficient means of doffing has promise for use in other machinery applications. The new air-brush doffer is similar in design to a centrifugal blower, with brush sticks functioning as the blower blades. The doffer combines air blast with mechanical brush actions to efficiently open, doff, and supply the air necessary for conveying textile fibers to a subsequent process.

1810. **DESIGN OF THE SRRL GRANULAR CARD.** Miller, A. L.; and Brown, R. S. Textile Research J. *29:* 733–36. 1959. Excerpt published: Textile World *109:* 45–46. 1959.

A detailed, illustrated description is presented of the mechanical apparatus that replaces the revolving flat assembly on a cotton carding machine with a nonloading mechanism and eliminates the flat strips. The apparatus is simple; however, experience has shown that close adherence to the fabricating tolerances and installation adjustments is essential for proper performance. The design and advantages of carding without flats are discussed, and the theory, design, and results of a low-pressure lickerin cover and a preopener roll applicable to standard cards are presented.

1830. **A NEW WARP TENSION CONTROL DEVICE AND ITS APPLICATION.** Louis, G. L.; and Longworth, R. L. Textile Bull. *85* (8): 55–56. 1959.

The SRRL tension control device has proved to be a useful tool for research purposes; and it may have merit for controlling warp tension in the commercial production of high-count, hard-to-weave fabrics. Full details and engineering drawings of the device are available without charge from the Southern Regional Research Laboratory, Post Office Box 19687, New Orleans 19, La.

1829. **NEW TEXTILE CARD ROOM EQUIPMENT—AND A PLAN FOR THE FUTURE.** Rusca, R. A. J. Textile Inst. *50:* 360–77. 1959.

Research of the U.S. Department of Agriculture to develop new and improved cotton textile processing methods and equipment is briefly discussed. Design and performance data are presented on two new machines: The SRRL Opener-Cleaner, a 1,600-pound per hour blowing room machine that removes one-third of the trash in cotton with minimum loss of fiber in the waste; and the SRRL Flatless Card, a radical but simple modification of the carding engine that eliminates conventional revolving flats and flat strips and reduces nep count in the web. A program of research for the future is suggested that should lead to the development of a completely new concept and of equipment for processing cotton into substantially higher quality textile products at half the existing processing costs. A plan of work is outlined for from 5 to 10 years of fundamental research, followed by from 5 to 10 years of engineering, development, and evaluation activities.

1645. **CARDING WITHOUT FLATS—A REPORT ON THE SRRL CARD.** Rusca, R. A.; Miller, A. L.; and Brown, R. S. Textile Research J. *28:* 597–99. 1958.

An apparatus has been developed for converting conventional cards to carding without revolving flats. The device is simple, relatively inexpensive, and effective. It eliminates all flat waste, reduces dust and fly, decreases maintenance, and materially decreases the weight of the card. Evaluations of the apparatus under pilot-plant conditions show reductions of 50 to 75 percent in overall card waste, about the same nep count, and slightly more uniform sliver when compared with a conventional card in excellent condition. On the same card equipped with flats and without flats, waste is reduced 50 percent and neps about 30 percent; yarn strength is 2 percent less and yarn uniformity is the same. The apparatus appears to perform equally well on short, medium, and extra-long staple American cottons. It is anticipated that design details of the SRRL Carding Apparatus will be publicly available within the year.

1573. **AN INVESTIGATION OF AIR PRESSURES IN THE COTTON CARD.** Miller, A. L.; Brown, R. S.; and Rusca, R. A. Textile Research J. *28:* 593–96. 1958.

An investigation is reported of the air pressures in the conventional cotton card measured at strategic points with the card running idle and when processing cotton. Through the utilization of a sensitive electronic instrument capable of measuring pressures of .001 inch of water, both static and velocity determinations were made that have given an insight into the function of air in the card and have led to the development of a method of carding without the use of the conventional revolving flats.

1656. **AN INVESTIGATION OF POWER REQUIREMENTS FOR COTTON CARDING.** Miller, A. L.; and Brown, R. S. Textile Bull. *84* (9): 99, 102, 104–6. 1958.

No attempt will be made to indicate dollar savings that can be realized through power reduction at the card; however, if operating personnel are made just a little more conscious of the factors that tend to consume power, a saving is almost sure to follow. The major factors for reducing power consumption can be summed up as follows: (1) Reduce friction by maintaining a proper lubricating schedule with the proper lubricants, in accordance with the manufacturer's recommendation; (2) avoid unnecessary friction by maintaining proper clearances to prevent rubbing of moving parts; (3) avoid unnecessary bearing friction by repairing scarred journals and worn bearings, by periodically cleaning bearings, and by maintaining proper alinement of bearings, particularly the adjustable ones, such as that on the shaft that drives the feed roll and that on the doffer comb; (4) use roller bearings or ball bearings wherever possible in lieu of sleeve-type bearings; (5) use a longer starting period if necessary to reduce initial electrical overload.

1574. **MACHINE REMOVES ONE-THIRD OF THE TRASH.** Rusca, R. A.; and Wallace, E. F. Textile Ind. *124* (4): 145–46. 1958.

Essentially the SRRL Opener-Cleaner is the SRRL Opener plus a built-in cleaning mechanism. Evaluations of the Opener-Cleaner under pilot-scale conditions indicate that it removes an average of about one-third of the trash in cotton, depending on the type of cotton and trash, at a production rate of 1,500 pounds per hour. A schematic diagram of the machine and tabulations of cleaning efficiency, waste analysis, and length analysis of fiber content of the waste are included.

1508. **THE SRRL INTEGRATED SYSTEM FOR OPENING AND CLEANING COTTON—THE OPENER-CLEANER.** Rusca, R. A.; and Young, R. C. Textile Research J. *27:* 558–64. 1957.

An integrated system for cleaning cotton at textile mills is under development at the Southern Regional Research Laboratory. The theory and general design of the system and of one of its component machines, the Opener-Cleaner, are discussed. The results of laboratory evaluations, using five commercial varieties of cotton, are presented. Comparisons of the processing performance of a conventional opening-picking line and that of a experimental line with the Opener-Cleaner are favorable to the experimental line. The Opener-Cleaner alone provides 35-percent cleaning efficiency and 0.3-percent lint loss at 1,500 pounds per hour production.

1507. **THE SRRL INTEGRATED SYSTEM FOR OPENING AND CLEANING COTTON—THE CARDING CLEANER AND THE INTEGRATED UNIT.** Kyame, G. J.; and Latour, W. A. Textile Research J. *27:* 566–70. 1957.

The changes made in a conventional one-process picker to convert the unit into a commercial size carding cleaner are described. The results of pilot-scale tests of the machine in an experimental line are compared with those in a control line composed of conventional textile mill equipment. The data presented show that the carding cleaner line achieved an average efficiency of about 59 percent at a production rate of 435 pounds per hour, as compared with the control line, which achieved 35-percent cleaning at 356 pounds per hour. Lint losses are one-third to one-half of those observed in the control line. Also presented are data obtained in preliminary tests of a tentative integrated cleaning system comprised of the SRRL Opener-Cleaner and the SRRL Carding Cleaner. Nearly 82-percent cleaning with a lint loss of 0.70 percent was achieved for the integrated system as compared with 52-percent cleaning and 1.14-percent lint loss for the control line.

1278.1. **AN INTEGRATED SYSTEM FOR CLEANING COTTON AT TEXTILE MILLS.** Rusca, R. A. Textile Ind. *120* (1) : 108–9. 1956.

The plan for development of an integrated system for cleaning cotton is outlined. In such a system, the function of each machine would be integrated and synchronized with all the others. Some of the machines discussed are: The Opener-Cleaner, the Aerodynamic Cleaner, and the Carding Cleaner. A plant layout is given. If successful, the system would be capable of removing 75 to 90 percent of the trash from about 100,000 pounds of cotton in a 40-hour shift.

1278. **SRRL LOOM ATTACHMENT MAKES WEATHER-PROOF FABRICS.** Mayer, M., Jr., Textile World *106* (4) : 126–27, 200, 202, 204. 1956.

The SRRL loom attachment for weaving high-pickage fabrics has been improved to make it adaptable for several types of looms, and it can be powered with an overhead drive in addition to the cam drive. Results of 5-year service tests on tarpaulins woven with the attachment and used as athletic field covers show that, although the fabric wets immediately, leakage occurs at 54 cms. hydrostatic pressure against 56 cms. for unexposed fabric. Tables show physical properties of several high-pickage fabrics woven with the attachment, physical properties during the 5-year test, and comparison with physical properties of a regular tarpaulin before and after 6 months' exposure.

1150. **THE SRRL CARDING CLEANER.** Kyame, G. J.; and Mayer, M., Jr. Textile Research J. *25:* 476–80. 1955.

A detailed description is given of an experimental machine intended to meet the problem of cleaning created by mechanically harvested cotton. The machine is somewhat similar to a downstroke buckley-type cleaner, but the customary beater is replaced with a licker-in type of carding cylinder. Also described is an improved feed system using a novel type of roll, called an "anti-pluck" roll. The new feed roll permits rapidly advancing a relatively thin layer of cotton to the carding cylinder, while simultaneously resisting the efforts of the carding cylinder to pull away the cotton. This results in opening the cotton to such a degree that cleaning efficiencies as high as 60 to 68 percent in a single machine are feasible at production rates of 400 pounds per hour. Data are presented to show the performance achieved in a quarter-size experimental machine.

995. **THE RETRACTO-PIN CONTINUOUS CARD STRIPPER.** Rusca, R. A.; and Pettit, G. A. Textile Research J. *24:* 539–40. 1954. Also published as: NEW CONTINUOUS STRIPPER MAY CUT CARD WASTE 1%. Textile World *104* (4) : 80; and RETRACTO-PIN CONTINUOUS CARD STRIPPER. Textile Ind. *118* (4) : 181–82. 1954.

Because commercially available continuous card strippers would not be satisfactory for stripping the card when it is unusually heavily loaded, a new type of stripper has been developed that shows promise of being a practical aid to the textile industry in processing raw cotton. The device is still experimental, and test results are preliminary and incomplete. A small rotor traverses and strips the card cylinder of impacted fibers through a slot in the back plate. Small-diameter pins or wires remove impacted cotton from the card clothing, and a combination of mechanical forces and self-generated air currents returns these strips to the surface of the cylinder. The rotor is driven directly from the card by means of spinning frame tapes, and the slot in the back plate is sealed by a sliding metal strip.

993. **TRY THIS APRON-SPLICING JIG.** Pettit, G. A. Textile Ind. *118* (3) : 138. 1954.

A simple, easy-to-use, small jig makes a smooth, even, and pliable splice when replacing leather aprons on long-draft spinning frames. The splice is made by holding the apron ends in alinement and applying pressure to the glued area while splicing the apron directly on the frame. The jig is readily adjusted preparatory to making the splice and is quickly detached afterwards.

930. **MILL REPORTS ON THE SRRL OPENER.** Rusca, R. A.; and Young, R. C. Textile Ind. *117* (7) : 87–90. 1953.

The operating principle and laboratory performance of a new textile-opening machine developed at the Southern Regional Research Laboratory were described in an earlier paper. Experiences with SRRL-type cotton openers under representative mill conditions during the past 2 years indicate that the machine is a worthwhile investment. When it is properly installed and operated, the opener has no effect on fiber length or nep count. It produces an exceptionally well-opened and well-blended stock. Trash removal by standard textile cleaning equipment is facilitated, and the amount of spinnable fiber in the opening-picking waste is reduced.

639. **SRRL OPENER GIVING GOOD RESULTS: NEW CLEANER BEING DEVELOPED.** Rusca, R. A. Textile World *103* (5) : 135. 1953.

Performance of the SRRL Opener in full-scale operation at commercial mills is described. One of these mills is reported as saving $22,400 a year with the Opener. A cleaner designed to be operated in conjunction with the Opener is under study. The goal of cleaning research is removal of 50 percent of the trash in a single operation at 3,000 pounds per hour, with less than 5-percent fiber loss.

864.1. **THE SRRL OPENER.** Rusca, R. A. Textile Bull. *79* (5) : 80–81. 1953.

Increasing use of mechanical harvesting by cotton growers makes cleaning efficiency in the mill a necessity. Development of the SRRL Opener is the first step in a research program to improve cleaning of cotton in the mill by opening the cotton and making it more accessible for removing dirt and trash. The Opener is reported to turn out lint 25 percent more open than when it was baled at the gin. Operation of the Opener is described and mill performance records reported.

792. **IMPROVE YOUR FABRICS—WITH THE SRRL LOOM ATTACHMENT.** Mayer, M., Jr.; Kyame, G. J.; and Brown, J. J. Textile World *102* (7) : 114–15. 1952.

This Laboratory, using a German weaving device as a basis, produced an inexpensive loom attachment to weave lightweight cotton fabrics that are almost waterproof; fabrics of a uniform quality having a few reed marks; and fabrics of increased breaking strength. Pickage can be increased as much as 38 percent above normal. The principle of the attachment follows the pattern of the well-known method of raising the level of the warp line where additional tension is applied to a part of the warp at the beat-up.

711. **EXPERIMENTAL SLASHER FOR TEXTILES EMPLOYS GAS, INFRARED DRIER.** Kyame, G. J. Ind. Gas. *30* (10): 12–13, 31–32. 1952. Also published as: SLASHER DRYER USING GAS DEVELOPED AT SRRL. Textile World *102* (8): 143–44. 1952. INFRA-RED DRYING UNIT FOR SLASHERS. Textile Ind. *116* (11): 132–33. 1952. Condensation: A GAS-FIRED, INFRARED DRIER FOR SLASHING. Textile Age *16* (3): 68–69. 1952. Also in Ind. Heating, July 1952: 1273–74, 1276, 1278, 1280.

This gas-fired, infrared drier for use in a textile slasher is an elongated, double-walled structure, which in longitudinal cross section resembles a smoker's pipe. Four burners provide control over the intensity of the infrared radiation reaching the warp. It is possible that the unit, which is patented, may be the basis of low-cost, high-production slashing equipment. In a mill, 4 such driers, each 57 inches wide, might consume about 125,000 cu. ft. of gas per 24-hour day for drying sized warps. Engineering details may be obtained by writing the Southern Regional Research Laboratory.

524. **PRECISION PICKER KNOCK-OFF DEVELOPED AT SRRL.** Pettit, G. A. Textile World *101* (2): 153. 1951.

A precision knockoff motion for attachment to a conventional cotton textile picker is described. The attachment has been in operation for more than a year and has proved a worthwhile development for research laboratories and other organizations that must prepare picker laps of any specified lengths from 4 to 40 yards.

527. **AN EXPERIMENTAL, GAS-FIRED, INFRARED TEXTILE SLASHER.** Rusca, R. A.; and Kyame, G. J. Textile Research J. *21:* 445–50. 1951.

An experimental, gas-fired, infrared textile slasher designed by the textile engineers of the Southern Regional Research Laboratory is described. The slasher processes warps 21 inches wide on beams with 18-inch heads and is used in operations of pilot-plant scale. Among the features that represent departures from conventional methods of textile slashing are a new system for preparing and distributing the sizing material; a new and more flexible design of size box; an improved means for drying the size-impregnated warp, which combines the best features of radiant and convection drying methods; and a sensitive drive system capable of controlling the warp tension during processing.

526. **THE SRRL-TYPE COTTON OPENER.** Rusca, R. A.; and Young, R. C. Textile Ind. *115* (5): 107–11. 1951.

The wide adoption of machine picking, which produces cottons of higher trash content, as well as the normal supply of low-grade hand-picked cottons, emphasizes the need for new and improved methods of cleaning at textile mills. A machine for opening and fluffing up cotton to enable better cleaning by equipment already in the mills has been developed. The opener has been evolved from the feeder of cotton-cutting equipment designed by the Southern Laboratory during the war to permit the use of lint cotton in manufacturing gunpowder. Experimental results with the new opener on commercial cottons indicate a worthwhile saving in spinnable fiber and the production of cleaner picker laps. It is recommended that the opener should be installed in the mills at the end of the feed table from the blending hopper feeders. The design principles, engineering features, and performance data of the new opener are presented in detail.

473. **CONVERSION OF THE SACO-LOWELL SLIVER TESTER TO ELECTRICAL RECORDING.** Rusca, R. A. Textile Research J. *20:* 780–86. 1950. Also published as: CONVERTED SLIVER TESTER SPEEDS EVENNESS ANALYSIS. Textile World *101* (1): 120–21. 1951.

The usual recording chart of a Saco-Lowell sliver tester has been replaced by a series of electrical contacts over which the recording arm passes in accordance with the thickness of the sliver. The instrument is described and illustrated, and the theory and mechanics involved in its construction are discussed. The converted sliver tester has been used successfully at the Southern Regional Research Laboratory for more than a year in textile research applications.

575. **PROBLEMS OF MACHINE PICKING.** Rusca, R. A.; and Bennett, C. A. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51*: 441–44.

Problems at the gin and at the textile mill introduced by the mechanical harvesting of cotton are enumerated and discussed. Some of the Department of Agriculture research to solve these problems is presented, with particular reference to new methods of lint cleaning for gin use and opening equipment for mill use.

577. **BETTER WAYS TO HANDLE THE BALE.** Sens, C. L. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 445–52.

Progress in improving cotton textile machinery and processing techniques is reviewed. The principal developments have been one-process picking, high-draft roving and spinning, high-speed warping, hot-air slasher drying, weaving without shuttles, production of nonwoven fabrics, continuous process bleaching, and organized control of techniques. As a result, efficiency in operation has been increased; quality in most cases has been improved; and the all-important factor of relatively lower costs of manufacturing has been coped with successfully. Such developments support the cause of conducting research to strengthen the competitive position of cotton and to extend its end uses.

433. **CARD-FLAT SETTINGS INDICATED BY DIAL GAUGES.** Bogdan, J. F. Textile World *99* (10): 172. 1949.

A quick method for gaging the settings of card-flats to the cylinder has been worked out. The method greatly reduces the time required for this adjustment and is especially useful in pilot-plant work, where many changes must be made. Equipment and its operation are described in the illustrated article.

435. **MINIATURE SLASHER DEVELOPED AT N.C. STATE.** Shinn, W. E.; and Sink, C. B. Textile World *99* (8): 122–23, 210, 212. 1949.

A slasher is described that is small enough for use in pilot-plant and experimental work. The machine is built for processing a sheet of yarn 7 inches wide under conditions similar to those of the full-sized mill operation. Pictures of the machine, drawing, and detailed description are given in the publication.

115. **LABORATORY CUTTER FOR CLOTH STRIPS.** Kettering, J. H., and Cooper, A. S. Am. Dyestuff Reptr. *34:* 249. 1945.

A device used at the Southern Regional Research Laboratory for cutting cloth into strips of predetermined width and winding them into rolls is described. The device consists of a number of electric scissors mounted between suitable tension bars on a platform with a motor, speed-reducer, and windup beam.

Fiber Properties (Related to Processing Efficiency and Product Quality)

1814. **EFFECTS OF GIN DRYING AND CLEANING PRACTICES ON PROPERTIES OF BLEACHED AND RESIN TREATED FABRICS.** Grant, J. N.; Andrews, F. R.; and Tsoi, R. H. Textile Research J. *29:* 751–57. 1959.

Fabrics made from lint cotton subjected to 12 combinations of ginning practices—seed cotton cleaning, lint cleaning, and drying levels—were tested as gray, bleached, and resin-treated fabrics. The seed cottons dried to the lowest moisture level before ginning produced the weakest gray fabrics. Bleaching caused no accentuation of their differences in breaking and tearing strengths that could be associated with the ginning practice, since strengths of all 12 fabrics were reduced about the same amount. Resin treatment and laundering decreased the differences in strength among fabrics. Density of cellulose was slightly higher for the three lots dried to the lowest moisture level. Moisture regains of the bleached fabrics were essentially equal. Alkali centrifuge swelling values were more closely associated with fiber fineness than with the ginning practices. Among the fabrics, differential dyeing detected differences associated with fiber fineness but not with ginning practices. Degree of polymerization was reduced by bleaching but showed no consistent relation to seed-cotton treatment. Inconsistencies between samples within groups do not permit conclusions to be reached as to effects of seed-cotton cleaning or lint cleaning.

1813. **THE EFFECT OF THE SHORT FIBERS IN A COTTON ON ITS PROCESSING EFFICIENCY AND PRODUCT QUALITY. PART I. AFFECTING THE SHORT FIBER CONTENT BY THE ADDITION OF CUT COTTON FIBERS.** Tallant, J. D.; Fiori, L. A.; and Legendre, D. C. Textile Research J. *29:* 687–95. 1959. Condensations: THE EFFECT OF SHORT FIBERS ON SPINNING PERFORMANCE. Textile Bull. *85* (6): 36. 1959; and SHORT FIBERS ARE HARMFUL TO YARN AND FABRIC. Textile World *109* (8): 52–53. 1959.

The effect of the short fiber content of a cotton on processing efficiency and on yarn and fabric properties, long a speculative and controversial subject, is investigated to a limited extent by the technique of cutting sliver into ¼- and ½-inch segments and adding the resulting short fibers to the parent cotton. The results indicate that increases in short fibers are detrimental to virtually all yarn and fabric properties and require increased roving twist for efficient drafting during spinning. A 1-percent increase in fibers shorter than ⅜ inch causes a strength loss in yarns of somewhat more than 1 percent. The quantities of cotton processed were insufficient to draw conclusions on neps, waste, or processing efficiency. The effect of short fibers on these properties will be considered in subsequent papers.

1805. **BLENDING COTTONS DIFFERING WIDELY IN MATURITY. PART I: EFFECT ON PROPERTIES OF SINGLE YARNS.** Fiori, L. A.; Louis, G. L.; and Sands, J. E. Textile Research J. *29:* 706–16. 1959. Condensations: COARSE AND FINE COTTONS CAN BE BLENDED SUCCESSFULLY. Textile World *109* (8): 53–54. 1959; and THE EFFECTS OF BLENDING COTTONS OF DIFFERENT FIBER PROPERTIES. Textile Bull. *85* (6): 37, 40. 1959.

The blending of extremely fine and coarse cottons was investigated as a possible way of economically using these difficult-to-market cottons. Two cottons differing appreciably in fiber fineness (approximately 3 and 6 micrograms per inch) but having other pertinent fiber properties about equal were blended to produce a mixture averaging about 4 micrograms per inch in fineness. For comparative purposes, a control cotton also averaging about 4 micrograms per inch in fineness was used. The blended and control cottons were spun into coarse and medium yarns of varying twists and into yarn numbers suitable for weaving Type 128 sheeting (64 x 64). The spinning efficiency of the two cottons was evaluated on a pilot-plant basis in terms of ends down per thousand spindle hours. Waste, nep counts, yarn properties (skein and single-strand strength, break elongation, uniformity, and grade), and end breakage rate in spinning were similar for the blended and the control cottons. Microscopical examination of yarn cross sections did not reveal any migratory tendencies of either the fine or the coarse fibers. For the same yarn number, the blended and control cottons produced yarns of similar diameters and softness values.

1722. **FIBER STRUCTURE AND MECHANICAL PROPERTIES OF UNTREATED AND MODIFIED COTTONS.** Orr, R. S.; DeLuca, L. B.; Burgis, A. W.; and Grant, J. N. Textile Research J. *29:* 144–50. 1959.

A brief review of investigations relating fiber structure to mechanical properties of cotton is given. The relationship of fibril alinement, as measured by the X-ray technique, to the strength and elongation properties of cottons covering a wide range in physical properties is discussed. Alteration of mechanical properties of cotton brought about by degradation in hydrochloric acid, mercerization, decrystallization in ethylamine, resin treatment, and acetylation are related to changes in the fiber structure. The effects of stresses imposed during some treatments are discussed.

1720. **EFFECTS OF HEAT-DRYING ON THE PHYSICAL AND CHEMICAL PROPERTIES OF COTTONS.** Nelson, M. L.; Andrews, F. R.; and Grant, J. N. Textile Research J. *29* (3): 260–69. 1959.

The poor spinnability of some lots of gin-dried cotton has been attributed to overheating of the seed cotton. To determine what changes in the lint might be responsible, two series of gin-dried cottons and one series that was flash-heated in the laboratory were studied. Appropriate physical and chemical properties of the lint were measured, such as fiber length distribution, single-fiber and fiber-bundle strength and elongation, moisture regain, nepping potential, fiber friction, microscopical swelling, alkali swelling, wettability, fluorescence, copper number, carboxyl content, pH, infrared spectra, and wax properties. Limited spinning and weaving tests allowed yarn and fabric properties to be measured. Nearly all tests showed no evidence of radical permanent changes in lint properties. The one significant finding was an altered fiber-length distribution in some heated lots such that the proportion of shorter fibers was increased while the percentage of long fibers was slightly decreased. This change appeared to be correlated with poorer yarn appearance and uniformity, a slight reduction in yarn and fabric strength, and poorer resistance to flex-abrasion. A blend of unheated lint with enough short (cut) fibers to give a fiber-length distribution approximately the same as that of a gin-overheated lot produced yarns and fabric with properties in close agreement with the overheated lot whose fiber-length distribution was approximated by the blending. Laboratory tests showed that fiber strength was lower when tested immediately after heating—that is, when the moisture regain was temporarily greatly reduced. From this finding it is deduced that the change in length distribution is the result of excessive fiber breakage when lint is subjected to mechanical agitation at too low a moisture content.

1727. MECHANICAL PROPERTIES OF CHEMICALLY MODIFIED COTTONS. Conrad, C. M. J. Textile Inst. *50:* 133–60. 1959.

The mechanical properties of certain chemically modified cotton textiles studied in considerable detail mostly at the Southern Utilization Research and Development Division are summarized. Properties studied include breaking strength, yarn knot strength, tearing strength (Elmendorf), ultimate elongation, average tensile and flexural stiffness (modulus), toughness index (work of rupture), frictional behavior, creep, elastic recovery, resilience, and abrasion-resistance (flat and flex). Chemical modifications have included many types, but only those that increase the weight of the cellulose molecule through substitution of the hydroxyl groups are included in the present report. Among these are substitution with acetyl, cyanoethyl, carboxymethyl, carboxyethyl (*beta*-propiolactone), and benzyl groups. The changes in various mechanical properties are related to the type of product (fiber, yarn, or fabric), degree of substitution, conditions imposed during treatment, and construction of the textile. The "dilution" effect due to group weight increase of the cellulose molecules on such properties as strength, stiffness, and work of rupture is considered. Some interpretations of the results are made in terms of fine structure.

1651. EXCESSIVE DRYING AND FIBER DAMAGE. Grant, J. N.; and Merkel, C. M. Textile Bull. *84* (11): 48–51. 1958.

In several cottons excessively dried at the gins and in laboratory driers, sufficient changes in fiber properties were found to affect their processing qualities. The permanent changes in mean length and in quantity of short fibers seem to be responsible for the major effects on product qualities. These fiber length changes are attributed to breakage resulting from mechanical working of fibers temporarily weakened because of low moisture content. Textile products made from overdried cottons that had been mechanically worked by gins or lint cleaners had lower strength and abrasion resistance and poorer uniformity as yarns and fabrics than those processed from unheated cotton. Only slight changes in chemical properties could be detected in excessively dried cotton and none in moderately dried lint.

1652. EXCESSIVE DRYING AT THE GIN DAMAGES FIBER. Andrews, F. R.; and Griffin, A. C. Cotton Gin & Oil Mill Press *59* (20): 12, 15. 1958.

In cotton excessively dried at the gin, sufficient changes in fiber properties were found to account for alterations in yarn properties. The permanent reduction in length and the increase in quantity of short fibers seem to produce the major effects on product qualities. These fiber-length changes are attributed to the mechanical working of fibers temporarily weakened because of low moisture content. This weakened condition can persist in some cottons until the lint has passed through several processing stages in the textile mill; that is, until it has returned to a normal moisture equilibrium. Only slight changes in chemical properties could be detected in cotton dried excessively and none in those given moderate drying.

1437. EVALUATION OF THE YARN PROPERTIES OF A HIGH-STRENGTH INTERSPECIES COTTON. Brown, J. J.; Howell, N. A.; Fiori, L. A.; Sands, J. E.; and Little, H. W. Textile Research J. *27:* 332–39. 1957.

The reported results compare yarn properties of a high-strength (11.5 Pressley Index) Interspecies cotton with those of five other cottons having a comparatively wide range of fiber properties. The cottons were processed alike on conventional equipment into 18/1, 36/1, and 72/1 carded yarns using a range of twist multipliers from 2.75 to 5.75. The yarns were tested for uniformity, appearance, and strength; yarns made from the Interspecies cotton were as strong as those made from the much longer and finer Karnak cotton, and stronger than those made from the other cottons. The Interspecies and Karnak yarns were about equal in uniformity, both being more uniform than the other control yarns. A limited statistical analysis of yarn breaking strength data indicates that fiber strength is more important to yarn strength than either fiber fineness or length.

1432. MOISTURE REGAIN OF NATIVE COTTON WITH ANIONIC WETTING AGENTS. Koltun, S. P.; Nelson, M. L.; and Grant, J. N. Cotton Gin & Oil Mill Press *58* (9): 26–27. 1957.

Harvesting of cotton by spindle pickers is increasing in this country, and in many instances wetting agents are being used to reduce the amount of water required and to keep the spindles clean. To determine whether or not this practice causes the cotton to absorb and hold more moisture during subsequent handling, experiments were conducted using several of the more commonly used commercial wetting agents. Results of the tests indicate there is no appreciable effect on moisture regain.

1343. COTTON QUALITY AND FIBER PROPERTIES. PART VI: COMPARISON OF A MATCHED PAIR OF RAIN-GROWN AND IRRIGATED COTTONS. Wakeham, Helmut. Textile Research J. *26:* 925–36. 1956.

As examples of rain-grown and irrigated cotton, seven bales each of Mississippi rain-grown Deltapine 15 and California irrigated Acala 4-42 from the 1951 crop were processed into yarns and fabrics of standard constructions. Conventional fiber tests and tests for single-fiber mechanical properties indicated the cottons were alike in all properties except the energy required to uncrimp the fibers, which was consistently higher for the irrigated cotton. Conventional chemical tests also revealed that the irrigated cotton had a higher wax content, yielded a larger ash, and had a lower degree of polymerization. Definite processing superiority and slightly better product quality were observed for the rain-grown cotton in the processing comparison. From a practical point of view, however, no fundamental, deep-seated difference could be observed between the samples in this test.

1349. EFFECT OF COTTON FIBER BUNDLE BREAK ELONGATION AND OTHER FIBER PROPERTIES ON THE PROPERTIES OF A COARSE AND A MEDIUM SINGLES YARN. Fiori, L. A.; Sands, J. E.; Little, H. W.; and Grant, J. N. Textile Research J. *26:* 553–64. 1956.

Forty-three cottons were used to evaluate the relation of fiber bundle break elongation to yarn break elongation. These cottons were processed into a series of coarse and medium yarns of varying twists. Fiber break elongation, length, fineness, strength, length variability, and maturity were correlated with yarn break elongation at twists for maximum skein strength and maximum single-strand strength, and at two constant twists (4.00 T.M. and 5.00 T.M.). The yarns varied considerably in elongation-at-break and in strength. Yarn strength and break elongation were found to be directly related for the commercially grown short- and medium-staple cottons; but the long-staple and the experimental, strong-fibered cottons produced yarns whose strength was disproportionate to their fiber break elongation. Fiber break elongation ranked first and strength ranked second in importance as contributors to yarn elongation for a 30/1 yarn at twists for maximum strength based on multiple correlation analyses. The modulus (secand) of cotton fibers and yarns was found to be highly correlated when the cottons were spun with twists that yielded maximum strength. This study also demonstrated that spinning conditions, particularly spinning tension, appreciably affect yarn elongation.

1272. COTTON FIBER BUNDLE ELONGATION AND TENACITY AS RELATED TO SOME FIBER AND YARN PROPERTIES. Hertel, K. L.; and Craven, C. J. Textile Research J. *26:* 479–84. 1956.

Correlations of fiber bundle elongation and tenacity with processing and yarn properties for a number of different cottons were made in these studies. Samples of 680 cottons grown in different environments during the crop years 1951, 1953, and 1954 were studied, and results were tabulated and analyzed. The only yarn property found to be definitely correlated with fiber bundle elongation was yarn elongation. Fiber bundle elongation was also correlated with X-ray angle. Skein strength was highly correlated with tenacity measures at ⅛-inch gage length. Stelometer values of tenacity and elongation were very highly correlated with Instron values on the same cottons.

1275. THE EFFECT OF COTTON FIBER STRENGTH ON THE PROPERTIES OF 2-PLY CARDED YARNS. Fiori, L. A.; Brown, J. J.; and Sands, J. E. Textile Research J. *26:* 296–302. 1956.

Two cottons (Hopi Acala 50, an irrigated variety, and Variety A) and the single yarns used in a previous study, plus yarns spun from an additional cotton identified as Variety B, form the basis for the 2-ply constructions covered by this report. The single yarns were spun (Z-twist), using twist multipliers ranging from 2.75 to 5.75 in increments of 1.00. Each single-yarn twist construction was 2-ply twisted (S-twist) with the same range of twist multipliers. In addition, a "balanced" ply twist construction was made wherein the ply twist multiplier was found to be approximately 0.7 times the single-yarn twist multiplier. Single-yarn number was held as constant as possible by varying the spinning draft to compensate for the contraction due to twist. It was found that for cottons of comparable fiber length and weight fineness the stronger fibered cotton produced the stronger 2-ply yarns. Also, differences in fiber strength do not affect twist-strength trends or percentage gain in strength of 2-ply over single yarns. The results of this study also indicate that fiber elongation is directly related to 2-ply yarn elongation.

1274. COTTON QUALITY AND FIBER PROPERTIES. PART IV: THE RELATION BETWEEN SINGLE FIBER PROPERTIES AND THE BEHAVIOR OF BUNDLES, SLIVERS, AND YARNS. Virgin, W. P.; and Wakeham, Helmut. Textile Research J. *26:* 177–91. 1956.

The purpose of this study was to evaluate the use of single-fiber testing methods for the determination of cotton fiber properties and for the prediction of yarn quality. Samples of unprocessed cotton, finisher drawing sliver, and 36s carded yarn were obtained for 21 domestic cotton varieties representing extremes in length, fineness, and strength. Single fibers from all three processing stations were tested for their fineness and mechanical properties. The results were compared with the mechanical properties of the fiber bundles, slivers, and yarns. Correlation studies of the results show that all the mechanical properties measured on fibers are related to fiber fineness and, among the varieties, to fiber length. Bundle strengths and elongations at clamp spacings greater than 1.5 mm. relate well to fiber breaking strengths and elongations. Sliver force-extension slope is dependent on fiber fineness and fiber elastic modulus. Yarn strength depends strongly on fiber length, fineness, and elastic modulus, and only weakly on fiber strength; yarn elongation depends greatly on fiber elongation and elastic modulus. These observations suggest that yarn strength and elongation are related to the single-fiber properties and can be predicted from them fully as well as from bulk measurements of fineness and bundle strength data. They also indicate that elastic modulus is an important parameter for predicting fiber assembly behavior.

1201. RELATION OF SINGLE FIBER TO FLAT BUNDLE STRENGTH AND ELONGATION OF COTTON. Orr, R. S.; Weiss, L. C.; and Grant, J. N. Textile Research J. *25:* 939–46. 1955.

Seven cotton samples and one rayon sample were tested at various gage lengths, using the Stelometer. A method of estimating the slip length of fibers in a flat bundle test is derived and applied to these data in order to obtain a "corrected" gage length for use in calculating strain at break. Also, a method of calculating the maximum possible bundle tenacity from breaking load and elongation-at-break of single-cotton fibers is applied to previous single-fiber tensile data. The resulting derived values of bundle tenacity and percentage of elongation are compared with measurements made on fiber bundles at equivalent gage lengths. The flat bundle values of tenacity and elongation, measured with the Stelometer, show a good correlation with the values measured on single fibers.

1148. EVALUATION OF YARN PROPERTIES AND PROCESSING PERFORMANCE OF PIMA S–1 COTTON. Brown, J. J.; Howell, N. A.; Fiori, L. A.; and Sands, J. E. Textile Research J. *25:* 404–14. 1955.

Results are reported of a pilot-plant evaluation of Pima S–1 cotton using an Egyptian variety, Karnak, and an American-Egyptian variety, Pima 32, as controls. The three cottons were processed alike on conventional equipment into a range of relatively fine single- and 2-ply yarns. It was found that, within the limits of this study, the general processing performance of the Pima S–1 was equal to that of the Karnak and Pima 32 cottons. Regardless of the organizational variables used in the evaluation, the Pima S–1 cotton produced yarns of better appearance and uniformity than did the other two cottons.

1131. MEASUREMENT OF THE DRAG OF COTTON FIBERS. Mereness, H. A. Textile Research J. *25:* 363–72. 1955.

Since drag, or frictional resistance to drafting of the fibers, may play an important part in the performance of cotton in the mills, studies were undertaken to evaluate three or more methods of measuring this quality. The drag was determined in card-sliver form, using the card-sliver stress-envelope method, and as a sliver made by hand-carding, using the hand-sliver method. In general, for the 12 cottons studied, there was a significant correlation between fiber drag data obtained using both methods and skein-strength data obtained from yarns made from these cottons. There were, however, a few notable exceptions. Fiber drag data were found to correlate poorly with interfiber friction data obtained using the Hood Tester, a dynamic method. The procedures used for evaluating the various cotton fiber draw methods are described in detail.

1149. HOW VAT DYEING AFFECTS COTTON. Sands, J. E.; Fiori, L. A.; and Brown, J. J. Textile Ind. *119* (4): 116–20. 1955.

It is shown that the raw stock vat-dyeing process reduced fiber length slightly. In general, vat-dyed yarns are stronger than undyed yarns with the highest strength resulting from yarns dyed after spinning. Lower twists are required for maximum strength for vat-dyed than for undyed yarns. Yarns made from the dyed stock react less sensitively to low twists and more sensitively to high twists than do those made from undyed stock. Vat-dyed raw stock processes into yarns of lower grade than does undyed stock, with the high strength variety used in these studies producing yarns of better grade than the other two variations in either the dyed or the undyed state.

1065. **EFFECT OF FIBER PROPERTIES ON PRODUCT QUALITY AND PROCESSING EFFICIENCY.** Cheatham, R. J.; and Fiori, L. A. Proc. Am. Cotton Congr. *1954:* 35–46.

The Fibrograph for determining fiber length; the Pressley for measuring fiber strength; the Micronaire and Arealometer for evaluating fiber fineness; and the Causticaire method for determining fiber maturity, make it possible to obtain rapidly much more information than formerly on these fiber properties of different cottons and to correlate them with the properties of yarns. General and specific relations between fiber properties and yarn quality and processing efficiency are discussed.

1069. **COTTON QUALITY AND FIBER PROPERTIES. PART I: EFFECT OF MECHANICAL BLENDING ON COTTON FIBER PROPERTIES.** Wakeham, Helmut; Virgin, W. P.; and Spicer, N. Textile Research J. *24:* 802–9. 1954.

A serious problem in single-fiber testing is the preparation of a homogeneous sample from which fibers may be selected randomly. Mechanical blenders of the type developed for cotton by the U.S. Department of Agriculture greatly improved the homogeneity of a bulk fiber sample. This blender has been evaluated for the preparation of cotton fiber samples before single-fiber testing. Relatively small changes in mechanical behavior of the cotton fibers were observed as a result of blending. With the conventional three passes through the blender, breaking load decreased (less than 10 percent) with corresponding changes in breaking stress and energy to break. Fiber crimp was reduced and fiber length slightly increased by the fiber array method. Whether these changes in fiber properties can be avoided by proper fiber manipulation has not yet been investigated.

1081. **A LITERATURE SURVEY ON FIBER FRICTION.** Langston, J. H.; and Rainey, W. T., Jr. Textile Research J. *24:* 644–53. 1954.

Data contained in 137 references pertinent to the subject of increasing the friction of cotton fibers, bearing on the subject either directly or by analogy, have been summarized. Most of the material was located through a search of the following sources, either in their entirety or from 1905 to August 1953: *Chemical Abstracts, Industrial Arts Index, Journal of Textile Institute (Abstracts), Textile Research Journal (Abstracts)*, and *Textile Technology Digest.* Main categories are: (1) Measurement of frictional properties; (2) frictional properties of cellulosic fibers; (3) modification of fiber friction. Under this third classification are discussed colloidal silica; other silicon compounds; abrasives; resins; and metallic salts.

992. **EFFECT OF COTTON FIBER STRENGTH ON SINGLE-YARN PROPERTIES AND ON PROCESSING BEHAVIOR.** Fiori, L. A.; Brown, J. J.; and Sands, J. E. Textile Research J. *24:* 503–7. 1954.

Hopi Acala 50, with fiber strength of 96,000 p.s.i., and a variety of medium strength, 80,000 p.s.i. having other important fiber properties approximately equal, were processed alike on conventional equipment into 12/1, 22/1, 36/1, and 50/1 yarn numbers. Twist multipliers ranged from 2.75 to 6.75 in increments of one. Skein and single-strand strength data were plotted on semilogarithmic paper to show proportional rates of change in yarn strength for a given yarn number. The strength of the fiber had little or no effect on processing efficiency through spinning; as expected, fiber of high strength produced stronger yarns than did fiber of low strength for any given yarn number or twist. The amount of twist required to obtain maximum strength in single cotton yarns was not affected by fiber strength. The uniformity of products (slivers, rovings, single yarns) was not affected significantly, nor was the yarn elongation.

980. **CORRELATION OF YARN STRENGTH WITH FIBER STRENGTH MEASURED AT DIFFERENT GAUGE LENGTHS.** Brown, H. M. Textile Research J. *24:* 251–60. 1954.

An improved technique for flat-bundle tests of cotton fiber strength has been developed. It has been established that spacing the jaws of the tester 2 to 4 millimeters apart—instead of touching, as generally practiced—gives a more correct ranking of cotton in terms of the yarns to be spun from them. This finding indicates that some cottons now being rejected as weak on the basis of conventional flat-bundle strength tests would actually spin into satisfactory yarns. This subject was studied because many investigators question the use of the conventional so-called zero gage length used in the Pressley Tester. Data are reported on 105 cottons. Fiber strengths were measured with the Clemson Flat-Bundle Tester at 0-, 2-, 4-, 6-, and 8-millimeter gage length and were correlated with the strength of yarns spun from the same cottons.

983. **MILL LABORATORIES SHOW CLOSE AGREEMENT IN COTTON-FIBER TESTING.** Hopper, T. H. Textile World *104* (2): 131, 210, 212. 1954.

Mills obtain almost identical results in laboratory tests of physical properties of cotton fibers. Tests made by the same laboratory with the same operators agree more closely than do tests made by different laboratories. Fiber length was tested with the Fibrograph, strength with the Pressley Tester, and fineness with the Micronaire. Smaller differences would probably have been found if all laboratories had followed specific instructions for each test, maintained standard conditions in the testing rooms, and tested standard cottons of known properties.

856. **VISCOMETRIC STUDIES OF CELLULOSE IN COTTON IN RELATION TO MECHANICAL PROCESSING.** Conrad, C. M.; and Rusca, R. A. Textile Research J. *23:* 168–74. 1953.

To determine whether or not the mechanical processing of cotton fibers into yarn causes any chemical degradation to the cellulose, four sets of samples were studied. One set had been powdered in a Wiley mill; another, processed several times through the SRRL Cotton Opener. A third set had been mechanically processed conventionally in the Southern Laboratory's textile mill, and a fourth consisted of portions of samples used by investigators outside the Laboratory. Viscosity measurements determined by the SRRL simplified techniques failed to show any chemical damage to the cellulose that could be associated with ordinary textile processing.

782. **FIBER STRENGTH AND YARN STRENGTH (TEST INTERPRETATIONS IMPROVED BY KNOWLEDGE OF FIBER DIFFERENCES).** Grant, J. N. Textile Ind. *116* (7): 96–97. 1952.

Prediction of yarn strength from fiber strength depends partly on the testing methods. Selecting the longer fibers from a sample can bias the results of the test, since the strength of long fibers was found to be nearly always greater than that of short fibers in the same sample. It was learned that the average elongation-at-break of fibers of different varieties and the effect of twist on the strength of yarns produced from different cottons varied. Such information permits a better interpretation of results obtained in present tests and provides a basis for the development and use of improved testing methods.

783. **EFFECTS OF MECHANICAL PROCESSING OF COTTON ON THE PHYSICAL PROPERTIES OF FIBERS.** Grant, J. N.; Morlier, O. W.; and Scott, J. M. Textile Research J. *22:* 682–87. 1952.

Fibers from ginned cotton and from 16/2s yarn from cottons of different physical properties were tested as a bundle and as individual fibers to determine whether changes in properties, if any, could be attributed to the mechanical processing. Data on tenacity, length array distribution, and crystal alinement revealed no consistent differences between the cottons before and after processing. The maturity of carded cottons was slightly lower. Weight fineness and breaking load of individual fibers were unchanged, but elongation-at-break was decreased. A higher modulus in tension was obtained from load-elongation curves of processed fibers, with the greatest difference found for loads below 2 g.

791. **COTTON FIBER PROPERTIES—A KEY TO PROCESSING DIFFICULTIES.** Fiori, L. A. Proc. Am. Cotton Congr. *1952:* 38–45.

Processing problems and fiber properties are defined; and the effect of the development of rapid, new testing techniques is discussed. Some specific processing problems in relation to fiber properties and their investigation at the Southern Regional Research Laboratory and elsewhere are described. The importance of considering the effects of fiber fineness on processing is stressed. The complete utilization of fiber properties in processing should lead to better cotton products with maximum efficiency.

627. **EFFECTS OF COTTON FIBER FINENESS ON THE PHYSICAL PROPERTIES OF SINGLE YARNS.** Fiori, L. A., and Brown, J. J. Textile Research J. *21:* 750–57. 1951.

The effects of cotton fiber fineness on the physical properties of both coarse and fine single yarns of varying twist were investigated. The length factor was controlled by reducing the cottons to common quartile and mean lengths. The varieties studied—Seaberry Sea Island, Mesa Acala, Tanguis, and Rowden 41–B—ranged in fineness from 2.9 to 5.6 micrograms per inch and were approximately equal in other important fiber properties. A relation was found between fiber fineness and the turns per inch required in a single yarn to obtain the benefits of optimum yarn strength. Low-twist yarns decreased less rapidly from maximum strength when made from fine than when made from coarse fibers. In contrast, high-twist yarns decreased more rapidly in strength when made from fine than when made from coarse fibers. Yarns made from coarse fibers required more twist than those from fine fibers to attain maximum yarn strength. Fiber fineness did not materially affect yarn elongation. Fiber fineness was a critical factor of roving twist.

572. **THE SCIENTIST LOOKS AT COTTON.** Grant. J. N. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 400–4.

The three qualities of cotton—staple length, character, and grade—considered in commercial classification of cottons are discussed. Improvement in the performance of textile products has been secured by the selection of cottons by their physical properties to meet product requirements for definite service. Values for individual fiber characteristics, such as fiber strength, fineness, maturity, length uniformity, and chemical structure, are essential to an understanding of the mechanical behavior of cotton. Some of the instruments and methods used to obtain the specific values for these properties are described; and some comparisons are made of cotton fiber properties with those of other material fibers and of synthetic fibers.

478. **CALIFORNIA'S NEW COTTON SHOWS BIG IMPROVEMENT.** Goldthwait, C. F.; and Smith, H. O. Textile World *100* (9): 127, 310, 312, 314, 316. 1950.

The new Acala 4–42 cotton has been evaluated for fiber and processing properties. Tests substantiated, in general, the claim that the new strain is superior to Acala P–18–C in spinning quality, and results in yarns of 20 to 25 percent greater strength and usually about half as many neps. The properties of Acala 4–42, an irrigated cotton, were found to be more nearly like those of Deltapine 14 than those of Acala P–18–C.

444. **THE APPLICATION OF THE DIFFERENTIAL DYEING TEST FOR FIBER MATURITY TO THE PROCESSING OF COTTON.** Dean, J. D., Chairman.* Am. Dyestuff Reptr. *39:* 74–90. 1950.

A unique method for distinguishing mature and immature fibers by the use of dyes has been useful in a number of different applications during the processing of cottons. Differential dyeing has been applied successfully to indicate effectiveness of blending, to check on the production of neps during processing, and to indicate the nature of fibers in the waste. Examination of dyed stock and waste samples taken at the principal stages of yarn manufacture showed that the combing operation was the only process that produced a tendency toward the selective removal of thin-walled, immature fibers as waste. The dye test and the Micronaire have both been employed for identifying cottons likely to produce neps. To establish the relationship of maturity by the dye test and fineness by the Micronaire, two groups of samples were classified by both techniques. Simple correlations of 70 and 51 percent were obtained with these two groups of samples. Since the production of neps is influenced by maturity more than by any other single fiber property, the dye test would appear to be more reliable for identifying cottons likely to produce neps than would Micronaire fineness, which has less relation to maturity.

336. **RELATION OF SPECIFIC STRENGTH OF COTTON FIBERS TO FIBER LENGTH AND TESTING METHOD.** Grant, J. N.; and Morlier, O. W. Textile Research J. *18:* 481–87. 1948.

Four cottons in commercial production, covering a range of such physical properties as strength, length, and fineness, were studied in a comparison of two methods of determining fiber strength—the individual fiber test and the Pressley flat-bundle test. Because of the combing action in bundle preparation, cotton fibers broken in the flat-bundle test represent the longer fibers found in a sample of cotton. These remaining fibers are not representative of the length of the original sample; and, since fiber specific strength increases with fiber length, neither are they representative of the strength of the original sample. This increase in specific strength with increase in length is evident whether fibers are broken individually or in aggregates. The relationship between the logarithm of individual fiber tensile strength and the logarithm of the specimen length used is inversely linear. The flat-bundle test represents the strength of fibers whose specimen lengths were deduced to be between 1/16 and 3/32 inch.

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*S. J. Davis, C. F. Goldthwait, R. O. Simmons, H. M. Waddle, and H. O. Smith.

44. THE LATERAL EXPANSION OF COTTON FIBERS UNDER TENSION. Lyons, W. J. Textile Res. *13* (11) : 21–25. 1943.

Measurements on approximately 1,200 cotton fibers showed, in general, a lateral expansion under longitudinal tensions. Conditions of the test are described; and means of the measurements, with standard errors, are summarized in one table. In another table, the data are further summarized and their significance evaluated. The lateral expansion is presumed to have an influence on the behavior of yarns and cords under certain conditions.

Processing Organization

1816. GET THE MOST FROM YOUR ROVING TESTER. Simpson, Jack. Textile Ind. *123* (10) : 165, 167, 169, 171, 234, 236, 238–39. 1959.

A schematic diagram, is used to show that the Belger Roving Tester employs the principle that, for good processing and drafting qualities, particular hanks of roving should have certain strengths. This strength is determined by drafting slightly a specified length of roving. An equation is developed from which it is possible to determine the drafting force exerted by the Belger on any hank roving. Results of spinning trials using rovings tested by both the Belger Roving Tester and an instrument that completely breaks the roving indicate that a tester using a somewhat higher draft than that used by the Belger Tester would more accurately predict the drafting properties of rovings.

1844. WHAT SPINNING DRAFT DOES TO DOUBLE-ROVING YARNS. Simpson, Jack; and Sens, C. L. Textile Ind. *123* (9) : 100–3. 1959.

A study was made of the effect of spinning draft with the Whitin Casablanca double-apron and the Saco-Lowell Shaw single-apron drafting systems on the properties of yarns from double rovings of short-, medium-, and long-staple cottons. It was found that in general the count-strength product vs. spinning-draft curves for the yarns from double rovings were similar to those spun from the single rovings and reported in Part I. (What Spinning Draft Does to Yarn, Textile Ind. *123* (6) : 108–14. 1959.) At the spinning draft, which gave the highest yarn strength for each, the yarns from double rovings were generally stronger than those from single rovings. As was true with the yarns from single rovings (Part I), the effect of spinning draft with double rovings was more critical with the medium- and long- than with the short-staple cotton. When short-staple cotton was spun, better fiber control resulted with the double- than with the single-apron system.

1826. AN INSTRUMENT FOR MEASURING ROVING STRENGTH. Landstreet, C. B.; Simpson, Jack; and Hutchens, H. Textile Bull. *85* (7) : 45–48. 1959.

This is a general interest article describing the principle and operating characteristics of an instrument for measuring the breaking strength of roving, along with the testing techniques employed. Since the instrument is now available commercially, the results of previous articles dealing with it are summarized to show its usefulness in cotton processing and research.

1739. WHAT SPINNING DRAFT DOES TO YARN. Simpson, Jack; and Sens, C. L. Textile Ind. *123* (6) : 108–14. 1959.

The effect of spinning draft on yarn properties was studied. The investigation covered short-, medium-, and long-staple cottons for processing from single rovings over a wide range of drafts on both double- and single-apron drafting systems. It was found that, in general, an increase in draft resulted in a decrease in strength for coarse yarns; but it resulted in an increase and then a decrease for medium and fine yarns. The importance of selecting the correct spinning draft was demonstrated when it was shown that a loss of as much as 35 percent in yarn strength could result from an incorrect selection of spinning draft on the high side of the optimum, while as much as 10.5-percent loss in yarn strength can be realized by a faulty selection on the low side of optimum draft.

1661. PROGRESS REPORTS ON USE AND APPLICATION OF THE NEPOTOMETER: SOME FACTORS THAT AFFECT TEST RESULTS. Markezich, A. R.; Tallant, J. D.; and Worner, R. K. Textile Research J. *28:* 570–75. 1958. Condensation: Textile World *108* (5) : 92, 142. 1958.

The nepotometer is in many respects a miniature card designed to simulate on laboratory samples of cotton the effects of action encountered during the carding operation that are largely responsible for nep formation. It was developed at the North Carolina State College School of Textiles, under a contract with the U.S. Department of Agriculture, to predict the nepping potential of cottons. The use of a standard-weight test specimen does not necessarily produce a standard-weight web. Since evaluations are based on comparison of the webs with appearance standards, the production of a constant-weight web in the test is believed to be necessary. The possibility of controlling web weight by consideration of some readily determined property such as Micronaire reading or Fibrograph upper half mean length, or a combination of these, appears promising. Two simple equations have been derived for determining the specimen weight to use for a fixed web weight—one based on Micronaire reading and the other on upper half mean length. Good correlation was found between the log of neps per grain and the photographic standards when the web weights were approximately constant. The regression curve above Grade 1 was essentially a straight line. Neppiness standards following a regular progression can be obtained from the present photographic grades by adding another grade between the present Grades 1 and 2.

1492. COMBED ROVING TWIST FORMULA. Simpson, Jack; Corley, J. R.; and Schnabel, G. G. Textile Research J. *27:* 486–92. 1957.

This study revealed that the twist required in rovings of combed cottons for good processing and drafting qualities varies directly with the hank roving, fiber fineness (Micronaire), and the variation of fiber length (both the uniformity ratio from the Fibrograph and the percentage of coefficient of variation from the Suter Webb Sorter). The twist varies inversely with the percentage of noils removed and the fiber length (Classer's staple length and upper half mean from the Fibrograph). Four of these variables were incorporated into a formula, and a correction method was devised for the fifth variable. A nomograph based on this formula was constructed, which enables rapid determination of the twist required in rovings ranging from 0.25 to 10.0 hank, using combed cottons varying widely in fiber fineness, staple length, and percentage of noils removed.

1436. THE RELATION OF TWIST TO THE CONSTRUCTION AND STRENGTH OF COTTON ROVINGS AND YARNS. Landstreet, C. B.; Ewald, P. R.; and Simpson, Jack. Textile Research J. *27:* 486–92. 1957.

A study was made to determine the shape of a complete twist-strength curve of a fibrous strand, especially beyond the area of maximum strength. A method was developed for predetermining the twist to insert into yarn for maximum strength. This method made use of the following variables: (1) Yarn number, (2) percentage of yarn contraction, (3) fiber fineness, and (4) fiber length.

1495. IMPROVE DRAWING SLIVER UNIFORMITY. Corley, J. R.; and Sandila, D. M. Textile Ind. *121* (11): 129–35. 1957.

This report deals with the effect of doubling and tension draft in the middle drafting zone, coupled with proportionment of draft between zones, on the uniformity of drawing sliver and roving and on yarn properties. Effects of roll settings and weights were also studied to a limited extent. Information developed indicates that: (1) If slivers fed and total draft are increased, within-yard variation increases and yard-to-yard variation decreases; (2) sliver uniformity is improved if middle drafting zone rolls are set closer together than is customary; (3) for a total draft of 6.00, rear-zone drafts of 1.56 to 2.00 give the most uniform sliver; (4) heavy roll weights improve sliver uniformity. Tables and bar graphs present statistical details of the studies and results.

1351. THE EFFECT OF TWIST ON THE STATIC MODULUS OF COTTON HAWSER-TWIST CORD. Tallant, J. D.; and Brown, J. J. Textile Research J. *26*: 523–24. 1956.

Quantitative data are presented on the relative effects of twist on the modulus of cotton hawser-twist cord of a single construction. The analysis was made of data obtained on a series of 54 cords of 16's/4/3 construction with ZZS twist in a number of twist combinations. Increasing the twist 1 t.p.i. in the components of the series appeared to lower the modulus approximately 1 g./grex/t.p.i. if in either the singles or ply, and 1.5 g./grex/t.p.i. if in the cord. Although the absolute magnitude of the effect on the modulus might be expected to change with different cottons and processing organizations, its relative values are probably applicable to 16's/4/3 hawser-twisted cord.

1277. SOME HISTORICAL AND TECHNICAL ASPECTS OF SPINNING. Rusca, R. A.; and Brown, R. S. Textile Research J. *26*: 460–69. 1956.

A brief history of the development of ring-spinning equipment is presented, and some of the economic and technical factors limiting further improvement of modern spinning machinery are pointed out. The discussion emphasizes drafting system and ring and traveler difficulties. Several new ideas and experimental machines for drafting or twisting are illustrated, and a brief discussion is given of the basic principles of each.

1276. LIMITATIONS OF THE INDIRECT UNTWIST-TWIST AND DIRECT-COUNTING METHODS FOR DETERMINING TWIST IN CARDED COTTON SINGLE YARNS. Worner, R. K. Textile Research J. *26:* 455–59. 1956.

When carded mock-grandelle type yarns were subjected to different tensions in the untwist-twist test, twist values increased as tension was increased; but none of the tensions tried produced the "machine" or "theoretical" twist. Nine yarns were tested: 15s, 30s, and 45s, each with twist multipliers of approximately 3, 4, and 5, at three different tensions, namely grex/20 grams, 156/cotton count (grams), and 3 grams. When the distribution of twist in each successive inch of a 15s, 5 T.M. yarn was observed during the test, retwisting occurred before the initial twist had been completely removed. When reverse twist equal to the initial number of turns was inserted, the yarn was more taut and had a slightly different order of distribution of twist in the successive lengths than was observed in the original yarn. If the reinsertion of twist was continued only until the original tension was restored, fewer turns of reverse twist were required and an underestimate of twist was obtained. At least two different factors, opposite in effect and varying with different yarns, appear to be operating simultaneously during the test, namely: (1) Torsional effects due to mechanical strains that influence the stress-strain relations and lead to underestimates, and (2) slippage of fibers, which results in overestimates. The agreement between direct and indirect methods for counting twist will depend on the extent to which each of these factors operates in the yarn being tested. Actual count of the turns of twist in cotton single yarns is considered the most reliable and suitable method for research and arbitration, but this method has limitations for routine testing and quality control work because of the time required and the tediousness of the test.

1361. SOME OBSERVATIONS OF MAXIMUM YARN STRENGTH AND ITS RELATION TO PROCESSING EFFICIENCY. Fiori, L. A.; and Sands, J. E. Textile Quality Control Papers *3:* 218–25. 1956.

Maximum yarn strength is discussed in terms of a "plateau" rather than a point on the twist-strength curve with the differences between skein count-strength product values at several consecutive increments of twist shown not to be statistically significant. The characteristics of twist-strength curves are explained, using actual, machine, and so-called nominal twists. The relationship of yarn-breaking elongation is discussed in terms of probable yarn-processing requirements, based on the concepts of average stiffness or toughness properties. Yarn-breaking elongation is shown not to be related to staple length.

1350. THE EFFECT OF TWIST ON ROVING STRENGTH. Simpson, Jack; Landstreet, C. B.; Schnabel, Gerald; and Hutchens, Herbert. Textile Quality Control Papers *3:* 70–78. 1956.

Reported are results obtained to date in a study of the effect that twist exerts on roving strength. The study is being conducted cooperatively by the Southern Utilization Research and Development Division and the Field Crops Research Branch. The roving strength testers used in the study, which were developed and constructed by Dr. K. L. Hertel of the University of Tennessee, are described. Data are presented that indicate that the pressure between fibers necessary for good drafting of roving is greater for the fine hank roving (small diameters) than for the coarse hank roving (large diameters); that the twist-strength curve for rovings made from combed cotton is lower than the curve for roving made from carded cotton, while in yarn this relationship is reversed; that the strength of the rovings increases with storage; and that an increase in humidity results in an increase in strength, especially at the higher twists.

1346. DRAFT PROPORTIONMENT FOR MEDIUM- AND LONG-STAPLE COTTONS ON LONG-DRAFT ROVING SYSTEMS. Corley, J. R.; and Simpson, Jack. Textile Ind. *120* (12): 114–19. 1956.

Four variables (total draft, fiber fineness, weight sliver, and staple length) were evaluated to develop the proper proportionment of draft on three long-draft roving systems. The results of the study revealed that, with long-draft systems operating under conventional procedures, the significant factors that affect draft proportionment are: (1) Total draft, (2) weight of sliver fed, and (3) staple length of cotton. Fiber fineness was found not to affect the distribution of zone drafts to any noticeable extent and hence was not used in developing the formulas. Formulas developed for calculating draft proportionment on each of the three long-draft roving systems used are presented as a means of improving roving and yarn uniformity.

995.1. **THE NEPOTOMETER.** Bogdan, J. F. Textile Forum *11* (1): 10–13. 1954.

A method was needed for measuring accurately the nepping potential of cotton fibers where this could not be judged by the fiber characteristics commonly tested. To meet this need, an instrument was designed and constructed that would subject small samples to repetitions of the mechanical treatments characteristic of processing. Behavior of the samples indicates their nepping tendencies. Description of the machine and its operation, pictures, and some detail drawings are given.

980.2. **MEASUREMENT OF THE NEPPING POTENTIAL OF COTTON.** Bogdan, J. F. Textile Research J. *24:* 491–94. 1954.

It has been found that the more operations, or repetitions of an operation, to which cotton fibers are subjected, the greater their tendency to form neps. This principle has been made the basis for construction of a machine, the Nepotometer, to measure the nepping potential of cotton. The principles of the machine's structure and its operation are described.

989. **EFFECT OF SINGLE AND PLY TWISTS ON THE PROPERTIES OF A 31/2 CARDED COTTON YARN.** Fiori, L. A.; Brown, J. J.; and Sands, J. E. Textile Research J. *24:* 267–72. 1954.

990. **EFFECT OF SINGLE AND PLY TWISTS ON THE PROPERTIES OF A 15.5/2 CARDED COTTON YARN.** Fiori, L. A.; Brown, J. J.; and Sands, J. E. Textile Research J. *24:* 428–33. 1954.

991. **EFFECT OF SINGLE AND PLY TWISTS ON THE PROPERTIES OF 31/2 AND 15.5/2 CARDED COTTON YARNS.** Fiori, L. A.; Brown, J. J.; and Sands, J. E. Textile Research J. *24:* 526–34. 1954.

High-twist multipliers in the ply yarns and low-twist in the single yarns give 2-ply yarns with the greatest strength and elongation at the same time. Cotton manufacturers can apply this information to judge whether changes in their twist combinations would produce 2-ply yarns of better quality at lower cost. Deltapine cotton, a variety of average fiber properties, was spun into carded yarns using two yarn numbers: 31/1 and 15.5/1, both Z twists. Twist multipliers ranged from 2.9 to 6.9 in making single yarns of both yarn counts. These single yarns were used in making 2-ply yarns (31/2 and 15.5/2, both S twist) with twist multipliers ranging from 1.9 to 7.9. Results show that maximum values for strength and elongation of 2-ply yarns are not obtainable simultaneously—they must be compromised.

977. **A METHOD OF PREPARING BULK COTTONS FOR NEP COUNTING.** Orcutt, P. L.; and Wakeham, Helmut. Textile Research J. *23:* 614–16. 1953.

A mechanical method of preparing cotton for nep counting, applicable to bulk cottons, wastes, slivers, and rovings, has been developed that can replace time-consuming hand methods. It is based on use of the USDA-type fiber blender. With it, 6 nep counts can be made on one sample in about 330 minutes; and indications are that even fewer counts may be representative enough.

925. **NEW ROVING TWIST FORMULA.** Corley, J. R.; Simpson, Jack; Fiori, L. A.; and Brown, J. J. Textile Research J. *23:* 750–54. 1953.

A new roving twist formula has been developed, expressed by a mathematical equation. A nomograph based on the formula was constructed by means of standard construction techniques to enable rapid determination of the turns per inch of twist required in rovings ranging from 0.25 to 10 hank (size) from carded cottons varying widely in fiber fineness and length when the Micronaire fineness and classers' length are known. Insertion of the proper twist in roving should eliminate much nonuniform yarn caused by overtwisted and undertwisted roving, and should result in fewer ends down during spinning and better operating efficiency in subsequent stages.

790. **DRAFT PROPORTIONMENT FOR COARSE, SHORT-STAPLE COTTON WITH LONG-DRAFT ROVING SYSTEMS.** Corley, J. R.; and Simpson, Jack. Textile Ind. *116* (12): 125–31. 1952.

New draft guides for manufacturing roving from a representative coarse, short-staple cotton with three long-draft roving systems are presented. Tests are described that demonstrated the improvement of roving and yarn evenness achieved by use of the new proportions, as contrasted to results with the proportions given in the manufacturers' guides for the three systems.

712. **AN EVALUATION OF LONG- AND SHORT-TERM VARIATIONS IN SLIVER AND ROVING.** Simpson, Jack; Landstreet, C. B.; and Corley, J. R. Textile Research J. *22:* 42–48. 1952.

To study the effects of processing variables on product uniformity, a procedure for evaluating uniformity has been developed. Two types of variation, long- and short-term, are common in slivers, rovings, and yarns. By measuring only short-term variation, it was possible to study the effects of doubling and drafting on product uniformity; to develop drafting curves by which product variability may be predicted; and to develop a formula for the comparison of the variation in unequal counts of roving and yarn.

847. **NEPS AND HOW TO CONTROL THEM.** Bogdan, J. F.; and Feng, I. Y. T. Textile World *102* (5): 91–106. 1952.

Information on the causes and prevention of neps, developed in the course of a 3-year study, is presented. Basically, neps occur when fibers get out of control and roll around each other or become collapsed. General precautions are: Keep machines in good condition, free of rust, rough spots, and nicks; select cottons with low nep-forming tendencies; and use smooth-ginned cottons. Fiber characteristics that influence nep formation are discussed, and nepping tendencies of several varieties of cotton are compared. Severe treatment during picking and cleaning increases nep formation; cotton should be worked as little as possible. It should not be carried through pipes any more than is necessary; air currents should be controlled. Speeds and settings of licker-in, cylinders, flats, and doffers were also found to be of great importance in the prevention of neps; influences of these factors are discussed, and recommended speeds and settings for several varieties of cotton are given. All machinery should be kept in good condition. Other factors that influence the formation of neps are also discussed.

514. **WHAT HAPPENS TO COTTON IN MULTIPLE DRAWING?** Loveless, H. L. Textile World *100* (8): 110–11. 1950.

Multiple drawings were found to increase neps, strength, and uniformity of cotton slivers, and to decrease appearance and uniformity. After the first few drawings, the sliver began to look lustrous and shiny. As the number of drawings increased, the sliver began to look more "combed like" and to pull apart more easily. As the number of drawings approached 30, it was almost impossible to process the sliver further.

513. **A REVIEW OF LITERATURE ON NEPS.** Bogdan, J. F. Textile Ind. *114* (1) : 98–103, 105, 107. 1950.

A list of 95 references on neps is given. Various definitions of neps are quoted, and various theories as to the causes of neps are given, along with suggested methods for avoiding nep formation.

378. **DRAFTING LONG, FINE-FIBER COTTONS ON SUPER-DRAFT ROVING FRAME.** Corley, J. R. Textile Ind. *113* (3) : 110–13, 223. 1949.

Investigation of the nonuniformity of roving produced from long, fine-fiber cottons on the Super-Draft system disclosed that these fibers are more sensitive to the influences of draft allocation than are short, coarse-fiber cottons. After studies using both the existing draft table and a wide range of experimental settings, a new draft guide was developed that substantially improved the evenness of yarns and roving manufactured from two cottons with staples longer than 1 inch. This new draft guide employs advantageously three critical factors in draft allocation: The ratio of the rear zone draft to the total draft of the compound drafting section; the ratio of the rear-zone draft to the weight of the stock fed; and the length of the total draft of the compound drafting section.

434. **DEVELOPMENTS IN NEP CONTROL.** Loveless, H. L. Textile Forum *6* (3) : 11, 12, 30. 1949.

Several pieces of equipment have been developed for use in the control of neps. A specially designed template facilitates the counting of neps; its construction and the method of use are described. The author tells how to use dial gages to aid in adjusting card settings. A conveyor for use between the doffer and coiler head permits removal, inspection, and sampling of a full width card web. Another special device makes it possible to process narrow widths of combed picker lap. A method for producing a shadowgraph of card webs makes it possible to produce a silhouette that can be used to study the fibers in the web, and that can also be retained for a permanent record.

432. **NOMOGRAPH GIVES NEP COUNT PER UNIT WEIGHT.** Bogdan, J. F. Textile World *99* (10) : 128–29. 1949.

A simple alinement chart converts neps per 100 square inches of card web to neps per gram, and neps per 100 yards of 22s yarn. Equations show the relationship between standard methods of expressing neppiness.

431. **TEMPLATES FACILITATE COUNTING OF NEPS.** Bogdan, J. F. Textile World *99* (6) : 142. 1949.

A new style of template has been devised that holds the card web sample and exposes well-defined areas through circular openings to permit rapid, accurate counting of neps. The construction of the template and its advantages are described.

334. **EFFECT OF DRAFT DISTRIBUTION ON STRENGTH AND APPEARANCE OF COTTON YARN.** Fiori, L. A. Textile Ind. *112* (6) : 92–97. 1948.

Changes in drafts were studied with a view to assembling a system of drafting that would provide flexibility in mill operations without impairing yarn quality. Four different varieties of cotton representing extremes in staple length were used in identical experiments in which drafts were varied on the drawing, roving, and spinning machines. The effect of these variations on skein strength and grade of a single coarse yarn (15.75s) was determined. It was found that increases in draft on the drawing and roving frames did not materially affect either strength or grade, while increases in spinning drafts resulted in lower skein strength but had little or no effect on the grade of the yarn.

212. **EFFECT OF SKEIN LENGTH ON YARN NUMBER AND STRENGTH DETERMINATIONS OF COTTON YARNS.** Lewis, W. S. Textile Research J. *16:* 576–80. 1946.

Skeins of varying lengths prepared from each of 13 cotton yarns were tested for yarn number and strength; and the average results obtained from each skein length for a specified yarn were compared. Data are discussed and tabulated which show that, in the skein test customarily used in cotton mills to determine yarn number and strength, a much shorter length skein than the one known as standard (120 yards) is adequate, and skeins as short as 12 yards should be suitable for most control production testing. Other pertinent data are given, including the coefficients of variation of yarn number and strength for each series of tests.

Fabric Properties

1836. **PROPERTIES OF FABRICS PRODUCED FROM THREE EXTRA LONG STAPLE COTTONS.** Ruppenicker, G. F., Jr.; and Brown, J. J. Textile Research J. *29:* 567–73. 1959.

Results are reported of a comparative evaluation of the properties of fabrics produced from American-Egyptian Pima S–1; Egyptian Karnak; and Hybrid Strain 330, a high-strength Upland cotton. Relationships of some fiber and yarn properties to fabric properties are shown. The reactions of fabrics woven from these cottons to chemical finishing treatments (mercerization, scouring, bleaching, and dyeing) are also discussed. In general, the Pima S–1 cotton produced fabrics that were approximately equal in breaking and tearing strength to those made from Hybrid Strain 330 cotton and were stronger than those made from Karnak. Gray fabrics made from Pima S–1 had higher elongation, greater resistance to flex abrasion, and better draping qualities than those from the other two cottons. The finishing treatments had varied effects on the fabrics, but in most cases those made from Pima S–1 remained equal to or better than those made from the other cottons in the properties measured. Fiber and yarn properties were closely related to fabric properties.

1728. **MOISTURE REGAIN OF TIGHTLY WOVEN COTTON FABRICS.** Skau, E. L.; and Honold, Edith. Textile Research J. *29:* 96–97. 1959.

Experimental data are presented from which it can be concluded that the mechanical restraints to swelling in a tightly woven cotton fabric are sufficient to result in a measurably lower moisture regain than that for the loose yarns when exposed to even moderate relative humidities. The compression of the fibers prevents them from swelling freely and thus limits the amount of water they can sorb.

1147. **EFFECT OF FABRIC STRUCTURE ON FABRIC PROPERTIES.** Brown, J. J.; and Rusca, R. A. Textile Research J. *25:* 472–76. 1955.

Research leading to the development of specialized fabrics for an agency of the Department of Defense is described. Requirements called for the fabrics to be highly resistant to the passage of water and air and to possess relatively high tensile and tear strength, yet to be light in weight. The effects of seven types of fabric structure on the physical properties of the fabrics are discussed. Of the constructions tested, basket weaves offered an acceptable compromise among the properties desired, with a 2/2 basket being highly water resistant without any chemical treatment and a 3/3 basket being slightly less water resistant and slightly more tear resistant. Regardless of the weave, as the picks per inch were increased air and water resistance increased and tear strength decreased. Bleaching, mercerizing, and dyeing significantly decreased the tightness of the fabrics; however, application of a flame-retardant and water-repellent treatment almost restored the original resistance of the fabrics to the passage of water and air.

1053. **APPLICATION OF MERCURY-INTRUSION METHOD FOR DETERMINATION OF PORE-SIZE DISTRIBUTION TO MEMBRANE FILTERS.** Honold, Edith; and Skau, E. L. Sci. *120:* 805–806. 1954.

Results indicate that the effective pore sizes previously calculated from the mercury-intrusion measurements of the cotton textile are reasonably accurate. The pore-size distribution data obtained by this method should prove useful in theoretical and practical investigations dealing with the characteristics of these and similar types of filters—and, in fact, of a variety of porous materials.

923. **INTERFIBER PORE-SIZE DISTRIBUTION OF LINT COTTON.** Skau, E. L.; Honold, Edith; and Boudreau, W. A. Textile Research J. *23:* 798–803. 1953.

Pore-size distribution of textile materials by the mercury-intrusion method has been investigated by use of an adaptation of a commercially available high-pressure porometer. It appears possible to produce cotton wads, yarns, or fabrics whose pore-size distribution will approach specific requirements if due consideration is given to the weight fineness and cross-sectional shape in choosing the component fibers, to the degree of fiber packing, and to the proper mixing of dissimilar cotton fibers. In order to substantiate this hypothesis and to render it more usable, additional studies are needed to obtain a better qualitative, or more nearly quantitative, interrelation of the parameters involved.

533. **PORE-SIZE DISTRIBUTION IN A SELECTED SERIES OF CLOSELY WOVEN FABRICS.** Honold, Edith; and Skau, E. L. Textile Research J. *21:* 419–27. 1951.

The mercury-intrusion method for the determination of pore-size distribution was applied to 18 closely woven cotton fabrics chosen to show the effect of maturity count, pickage, and processing (scouring and Zelan finishing). The apparatus used permitted a survey of practically the whole (96 percent) of the available void enclosed by the sample. The pressuring curves of the mature-cotton fabrics disclosed a rather distinct separation between the filling of the surface depressions and that of the interfiber regions; the curves of the immature-cotton fabrics indicated a greater overlapping and blending of all regions. A comparison of the mature- and immature-cotton fabrics showed a shift in distribution toward smaller pore sizes in the latter. A similar trend to smaller pores was observed as the closeness of cloth weave was increased; this trend was further emphasized by a comparison of the fabric data with those obtained for the corresponding yarns. Processing resulted in a loss of total void volume included in the sample. The proportion of void volume within the interfiber pore sizes was increased at the expense of the volume within the surface depressions. A correlation between air permeability and the void volume of the interfiber range indicated that the interfiber pathways were the dominant factor in determining air permeability in these tightly woven fabrics.

438. **MEASUREMENT AND THEORY OF ABSORBENCY OF COTTON FABRICS.** Buras, E. M., Jr.; Goldthwait, C. F.; and Kraemer, R. M. Textile Research J. *20:* 239–48. 1950.

A simple and rapid absorbency-measuring test for application to cotton fabrics, using apparatus easy to assemble, evaluates numerically the rate of absorption and the ultimate absorption, largely independently of apparatus characteristics. The separate evaluation of these independent factors and the elimination of timing procedures set this test apart from those previously published. The method is readily adaptable to the investigation of many liquid-absorbent relationships, Applications of the test to the evaluation of absorbency of purified cotton fabrics have led to a plausible explanation of their absorption behavior as being largely due to the spaces within the fabric rather than to the absorption characteristics of the fiber itself.

402. **PORE-SIZE DISTRIBUTION IN TEXTILES.** Burleigh, E. G., Jr.; Wakeham, Helmut; Honold, Edith; and Skau, E. L. Textile Research J. *19:* 547–55. 1949.

After modification to permit measurements at lower pressure, the mercury-intrusion method for the study of the pore-size distribution of petroleum earths was applied to the study of fabrics. The results showed significant differences in the pore-size distribution curves of 10 selected fabrics. The peaks of these curves, predominantly a measure of the interfiber pore spaces, fell between pore radii of 2 and 4.5 microns, depending on such factors as fiber fineness or maturity and yarn compression. A comparison of the peak positions with data on air permeability indicated a correlation. High-pressure curves for cotton fibers suggested a collapsing of the lumen. Cotton fibers showed a volume change three times that of rayon filaments when each material was pressured to 10,000 p.s.i.a.

Testing

1754. **THE PRACTICE OF TEXTILE MICROSCOPY.** Rollins, M. L. Yearbook N.Y. Microscopical Soc., *No. 6:* 25–36. 1959.

The microscope has been used in textile research for more than 120 years. The first quarter of the 20th century saw a number of manuals and textbooks published on the subject, and the period following the Second World War has produced another group of books devoted to textile microscopy *per se*. The practice of textile microscopy encompasses studies of fabrics, yarns, and fibers at various stages of processing and finishing, and under various conditions of damage, deterioration, or wear. It includes fiber identification, yarn, and fabric analysis, as well as observations on the extent and uniformity of chemical substitution or impregnation treatments. Typical problems involving these operations are cited, and the application of the electron microscope to textiles is discussed.

1753. **METHOD USED FOR DETERMINING WARP CRIMP.** Kingsbery, E. C.; and Roddy, N. P. Textile Research J. *29:* 521–22. 1959.

A device has been developed to measure accurately an 18-inch length of warp yarn as it is pulled from the loom beam in weaving. This device is used to facilitate the determination of crimp in warp yarn. A photograph and a drawing of the device are included.

1655. **IMPROVEMENT ON THE SERVO CONVERSION OF MANUAL FIBROGRAPHS.** Tallant, J. D. Textile Research J. *28:* 815. 1958.

Simple instructions for the improvement of the servo converted manual fibrographs are given. The addition of a small condenser, a resistor, and two diodes is recommended. If these modifications are made, more stable operation, greater accuracy, and higher speed are obtained.

1841. **A TEX-COTTON COUNT CONVERSION SCALE.** Louis, G. L. Textile Research J. *28:* 716–17. 1958.

A useful conversion scale is proposed as a convenient method of converting yarn size from cotton count to tex, or vice versa, based on the relationship that tex = 590.54/cotton count. The scale is applicable to both yarns and roving with sizes that are common and popular in U.S. textile mills and is designed as a substitution for massive conversion tables when only the approximate value is needed.

1590. **SPINNING TESTS.** Little, H. W.; Fiori, L. A.; and Sands, J. E. Textile Ind. *122* (3): 107–10, 121, 123, 126–27. 1958.

The meaning of the term "spinning test" is described in general terms and a definition given. Spinning tests are classified as to purpose, size, and criteria evaluated. Purpose as related to size and scope of test is discussed. The importance of measuring and indicating the reliability of test results is emphasized, and the more elementary techniques for accomplishing this are explained. The latter part of the report is devoted to a consideration of some of the questions that arise in the application of spinning tests, such as the number of observations required to attain a desired reliability, and the presentation of specific examples of the application of spinning tests to various types of problems.

1575. **A METHOD FOR MEASURING YARN SOFTNESS AND ITS USE TO SHOW THE EFFECT OF SINGLE AND PLY TWIST ON THE SOFTNESS OF 31/2 COTTON YARNS.** Skau, E. L.; Honold, Edith; and Boudreau, W. A. Textile Research J. *28:* 206–12. 1958.

An apparatus is described for measuring yarn softness in terms of the percentage of increase in yarn width when the yarn is subject to lateral pressure between two parallel plane surfaces. Softness data obtained on a family of 31/2 cotton yarns have been presented as a contour diagram which, in connection with similar contour diagrams of other important yarn properties, shows the interrelationship of these properties over a wide range of single- and ply-twist combinations.

1653. **HOW FEASIBLE IS A SINGLE TEST FOR FIBER STRENGTH, MATURITY, AND FINENESS?** Hopper, T. H. Proc. 11th Ann. Cotton Merchandising Clinic, *1958:* 44–52.

Reasoning from the correlations found between and among physical properties and compositional factors for certain oilseeds and vegetable oils, it is postulated that it may be feasible to develop a single test for strength, maturity, and fineness of cotton. To accomplish this, it may be necessary to develop new objective tests and test instruments. Some data are given that indicate the level of correlation between the fiber properties as obtained by use of present instruments.

1664. **TRANSITION FROM SUBJECTIVE TO OBJECTIVE COTTON TESTING.** Hopper, T. H. Proc. 10th Ann. Cotton Merchandising Clinic, *1958:* 48–50.

The current transition from subjective to objective cotton testing is cited as being similar to changes already made in the evaluation of wheat, oilseeds, and other commodities for marketing purposes. The gain made in objective testing of cotton would be enhanced through the development of new instruments to provide for rapid testing at low cost and the establishment of rules and levels of test for their use in marketing.

1433. **NOMOGRAPH FOR EXTENDING THE RANGE OF THE AREALOMETER.** Tallant, J. D. Textile Research J. *27:* 436–38. 1957.

Occasionally there is need to evaluate cottons that are beyond the range of the Arealometer's calibration. Through analysis of the relationships between air-flow resistance and specimen size, a formula and nomograph are developed that extend the scale to cover these anomalous cottons. For extremely fine and immature cottons, a specimen mass of 75 percent of normal has been found practical. The test is conducted in the usual manner, and the dial value is then converted to the true value by means of either the nomograph or the equation. Procedures are also outlined for use with extremely coarse cottons and for altering the mass to give a definite value for the void fraction.

1430. **A COMPARISON OF EGYPTIAN AND AMERICAN METHODS FOR EVALUATING COTTON QUALITY.** Abou Sehly, A. A. H.; Tallant, J. D.; and Worner, R. K. Textile Research J. *27:* 73–78. 1957.

Comparative data on fiber properties are reported for 12 samples of Egyptian cotton, using the different techniques employed at the Giza Spinning Test Mill in Egypt and at the Southern Regional Research Laboratory. Results obtained with the Ball's Sorter, which is commonly used in Egypt for length measurements but is little known in America, were found to correlate highly but at a different level with Fibrograph and Suter-Webb array data. Both laboratories use the Micronaire and the Pressley Tester. The test results were used to illustrate how the Giza Spinning Test Mill applies the length fineness ratio for separating cottons into categories. The strength of the cottons in these categories is then indicative of whether a particular cotton is anomalously strong or weak. This relationship provides a criterion for determining the suitability of a new variety for possible commercial development, as well as for selecting cottons for specific end uses.

1360. **SOME NEGLECTED AND UNEXPLORED PHASES OF COTTON FIBER MEASUREMENTS.** Hopper, T. H. Proc. Ninth Ann. Cotton Merchandising Clinic, *1956:* 88–90.

Tests for the measurement of the fiber properties of cotton could be used much more extensively and intensively. To bring this about, methods of rapid and low-cost testing are needed, as well as greater knowledge of their potential uses. Properties to be measured and uses to which knowledge of these properties can be put for the improvement of processing quality and end uses are discussed.

1202. **RELIABILITY AND USE OF THE SPINNING TEST TO EVALUATE COTTON QUALITY.** Fiori, L. A.; Sands, J. E.; and Little, H. W. Proc. Eighth Ann. Cotton Merchandising Clinic, *1955:* 48–50.

The spinning test is defined, and types are discussed in detail. Purposes for which the spinning test is used and the measures of quality for evaluation of results are also discussed. Data obtained from a spinning test are considered from two points of view: Evaluation of reliability by statistical analyses, and use for determining the processing performance of cottons and textile machinery and methods. Under reliability, skein and single-strand strength data of single- and 2-ply yarns are discussed. Extremes in variability based on strength observations are shown, as are statistical techniques used to establish testing programs to secure reliable results. The effects of roving storage on the reproducibility of yarn strength, and the effects of spinning draft constants on variability or yarn number are presented. Examples showing the use of the spinning test at the Southern Regional Research Laboratory are given.

1198. **FABRIC EMBEDDING FOR MICROTOME SECTIONING.** DeGruy, I. V. Textile Research J. *25:* 887–88. 1955.

A modified embedding technique for the preparation of fabric samples for microtome sectioning has been developed. Where other methods require the use of monomeric materials that must be polymerized in an oven, this technique employs a viscous aqueous solution of polyvinyl alcohol that hardens overnight at room temperature. The aqueous solution permits embedding and sectioning of coated fabrics that would be distorted by swelling of the coating in the usual embedding media. Materials and methods are described.

981. **THE MICROSCOPE AND THE COTTON MILL.** DeGruy, I. V.; and Rollins, M. L. Textile Ind. *118* (6): 114–53. 1954.

Various microscopical techniques are used to investigate problems that arise in cotton textile mills. Fourteen photomicrographs show views of fibers depicting possible sources of spinning difficulties; number and maturity of fibers, their peripheral characteristics, and airspaces; uniformity of fiber blends; neps and stains; effects of water; penetration of chemical treatments; or molecular modification. Electron microscope views detail fine structure of cotton's primary wall, of untreated and mercerized fiber.

982. **DEVIATIONS IN INSTRUMENTAL EVALUATION OF THE PHYSICAL PROPERTIES OF COTTON.** Hopper, T. H.; and Tallant, J. D. Textile Research J. *24:* 53–57. 1954.

Increased use by mills and laboratories of the Fibrograph to measure length, of the Pressley Tester to measure strength, and of the Micronaire to measure fineness of fibers, has indicated a need to maintain uniform levels of testing within a laboratory and between laboratories throughout the country. The sample-testing program was sponsored by Committee D–13 of the American Society for Testing Materials during 1951 and 1952.

928. **EXPLANATION OF CORRECTION FACTORS FOR THE USTER UNIFORMITY TESTER.** Oser, L. F.; and Fiori, L. A. Textile Ind. *117* (7): 123. 1953.

The operating principles of the Uster Uniformity Tester that make necessary the use of correction factors for both the Integrator and the Range values are explained, and the mathematical derivation of these factors is outlined.

864. **HOW TO IMPROVE WINDING OF YARN-GRADING BOARDS.** Wallace, E. F. Textile World *103* (3): 111. 1953.

Modifications of the Suter Yarn Evenness Controller are described that enable the instrument to more accurately and uniformly wind yarn boards used for the evaluation of yarn grade according to ASTM yarn appearance standards.

924. **SOME APPLICATIONS OF LIGHT MICROSCOPY IN THE STUDY OF TEXTILE MATERIALS.** Tripp, V. W. Am. Soc. Testing Materials, Symposium on Light Microscopy, Spec. Publ. No. *143:* 25–34. 1953.

Some of the objectives of textile microscopy are set forth, and accepted methods of accomplishing them are described and illustrated. Apparatus of textile microscopy; fiber identification and analysis; fiber measurements of diameter, thickness, or cross-sectional area; and preparation of cross sections are discussed. The use of the techniques discussed in studies of textile processing and behavior is described and illustrated.

921. **A SINGLE-FIBER LOAD-ELONGATION TESTER FOR COTTON.** Orr, R. S.; and Grant, J. N. Textile Research J. *23:* 505–9. 1953.

A single-fiber tester of the type employing a constant rate of loading is described. It is designed especially for obtaining load-elongation curves in addition to end-point data on cotton fibers, and it employs coiled-spring loading and optical means of recording. Devices are incorporated that permit cyclic loading studies and static life determinations. An oven and humidification tank are provided for testing at various temperatures and under various moisture conditions.

788. **USE OF A SERVO SYSTEM FOR AUTOMATIC OPERATION OF THE FIBROGRAPH.** Tallant, J. D. Textile Research J. *22:* 617–19. 1952.

The Fibrograph can be converted to automatic operation by using a small, low-speed motor to drive the left handwheel and by replacing the galvanometer and manual operation of the right handwheel with a servo system to maintain balance by driving this handwheel. The accessories required are rugged and are commercially available. Smoother curves are obtained by this method, and the operator is free to comb the next test sample while the curve is being drawn.

785. **CHECK SAMPLE TESTING OF PHYSICAL PROPERTIES OF COTTON WITH INSTRUMENTS (A SUMMARY REPORT PREPARED FOR THE TASK GROUP ON INTERLABORATORY CHECK SAMPLE TESTING OF COTTON FIBERS).** Hopper, T. H. Textile Research J. *22:* 472–75. 1952.

Increased use of instruments for the measurement of length, strength, and fineness of cotton indicates need of a uniform level of testing within a laboratory and between laboratories. To learn the uniformity with which results are obtained by use of the Fibrograph, Pressley, and Micronaire, a task group was appointed by Committee D–13, Subcommittee A–1–1, Cotton and Its Products, of the American Society for Testing Materials, to conduct a program of interlaboratory check sample testing, each laboratory to follow its regular test procedures. Results of the first tests indicate need for greater standardization.

710. **THE IMPORTANCE OF CORRECTING RANGE VALUES ON THE USTER UNIFORMITY TESTER.** Fiori, L. A.; and Oser, L. F. Textile Ind. *116* (1): 149, 151, 153, 169. 1952.

The range method is used far more widely with the Uster Uniformity Tester for determining product unevenness than is the integrator method, but unless correction factors are applied it is difficult to obtain comparable results by the range method from different machines. The purpose of this article is to show the necessity for applying these factors to eliminate machine and product variables. The effects of average value settings and yarn number changes, as well as the results when range is not corrected, are shown graphically. Range readings are generally corrected by choosing the factor corresponding to the average value reading of the integrator and multiplying this by the original unevenness reading. Also described is a method whereby an estimated average line can be used in place of the integrator average value reading.

620. **FIGURE EVENNESS BY MACHINE OR PLANIMETER?** Rusca, R. A. Textile Ind. *115* (7): 79–81. 1951.

Tests of the Uster Yarn Evenness Tester under slightly different atmospheric conditions at the Southern Regional Research Laboratory showed that the minor fluctuations in conditions did not significantly affect the measurement of long-term variations in product uniformity, but that they did affect the measurement of short-term variations. Reading percentages directly from the chart produced results comparable to those obtained by the use of a planimeter, and in one-eighth to one-tenth the time.

623. **APPARATUS FOR EVALUATING WARMTH OF TEXTILE FABRICS.** Tallant, J. D.; and Worner, R. K. Textile Research J. *21:* 591–96. 1951.

A semiautomatic apparatus requiring minimum operator attention has been assembled for measuring the thermal transmission of fabrics while subject to moving air at constant temperature. The difference in the amount of energy required to maintain constant temperature in a body when bare and when covered with the test specimen is measured. Conditions have been set up with an air velocity of 12 to 13 m.p.h. so that performance under fairly severe conditions of use can be approximated. The apparatus has been found to differentiate among fabrics ranging from thin, plain-weave, nylon cloth to heavy woolen blankets, and in a manner that apparently takes into account the various fabric properties.

567. **TESTS TO HELP YOU KNOW TEXTILES.** Worner, R. K. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 457–65.

A review is given of the wide variety of tests used to check the many individual properties of textiles, from the raw material to the finished fabric, and to predict their serviceability in specific end uses. Such tests are generally applied by cotton purchasing agents, by manufacturers, by research chemists, and a few even by consumers. The importance of making the tests under controlled conditions and standardized procedures is stressed. The qualities that are regularly tested include strength; colorfastness; launderability; air permeability; and resistance to water, mildew, fire, and abrasion. Some of the more complex characteristics important to the consumer for which test procedures have not yet been fully standardized include warmth, wear, and the properties relating to hand and appearance, such as crease resistance, pliability, drape, and luster.

564. **MEASURING THE ABSORBENCY OF COTTON.** Buras, E. M., Jr. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 419–20.

Absorbency-measuring tests that have been employed up to now are largely inadequate and arbitrary. A test method described here is more suitable in that it meets the requirements of wetting the fabric quickly from one side while it is under pressure and allowing the comparison of different fabrics in a readily understandable manner. The improved test is based on the use of automatic devices. The glass apparatus is easily assembled and calibrated. The simple, rapid test permits numerical evaluation of both rate of absorption and total or ultimate absorption, largely independent of apparatus characteristics. Application of the test to the evaluation of absorbency of purified cotton fabrics has led to a plausible explanation of their absorption behavior as being due largely to spaces within the fabric rather than to the absorption characteristics of the fiber itself.

365. **TEXTILES THROUGH THE MICROSCOPE.** de Gruy, I. V. Sci. Monthly *68:* 61–65. 1949.

Some of the investigations conducted at the Southern Laboratory are used to illustrate the role of the microscope in textile research. Textile microscopy has been applied to studies of tire cord construction, adhesion, and impregnation; to investigations of mercerized and chemically treated cottons and cotton dyeing; to problems of fiber identification; and to many other phases of research on fibers and fabrics. The fiber microscopist has unlimited opportunities to assist first the chemist and ultimately the manufacturer in developing improved materials for consumer use.

385. **AN INDEX OF THE WATER-REPELLENCY OF TEXTILES FROM THE SURFACE TENSION OF AQUEOUS SOLUTIONS.** Schuyten, H. A.; Weaver, J. W.; and Reid, J. D. Am. Dyestuff Reptr. *38:* 364–68. 1949.

A method has been devised for indicating the relative surface tensions of solids by determining the surface tension of a standard liquid that will wet the solid under selected conditions. The liquid selected was water containing various amounts of a wetting agent, prepared in such a manner as to obtain a series of solutions with surface tension values ranging from 26 to 72 dynes/cm. By use of solutions whose surface tensions are known, and by employing an electrical indicator, the point where fabrics become wet can be determined. The surface tension of the solution necessary to cause this wetting is taken as an index of water-repellency of the fabric. This system gives a range of at least 22 measurable units compared to 5 arbitrary units of the much-used spray test.

376. **USE OF PROBABILITY PAPER FOR ESTIMATING THE MEAN AND STANDARD DEVIATION OF NORMALLY DISTRIBUTED TEXTILE TEST DATA.** Tallant, J. D. Textile Research J. *19:* 270–73. 1949.

The use of probability paper for estimating the mean and standard deviation of normally distributed test data is illustrated through the use of textile test data for strength. The method is time-saving in handling a large number of samples. A brief discussion is given of the mathematical theory substantiating the method.

299. **DETERMINATION OF THE RATE OF WATER ABSORPTION OF LIGHTWEIGHT COTTON FABRICS.** Kettering, J. H. Am. Dyestuff Reptr. *37:* 73–75. 1948.

A simple, rapid procedure is suggested for determining the rate of water absorbency of lightweight fabrics, and the necessary apparatus is described. The method consists essentially of determining the time required for a disk of test fabric to absorb a measured volume of water from the surface of a porous plate. It gave fairly reproducible results in the hands of different operators and compared favorably with two other widely used methods for measuring absorbencies.

205. **AN APPROXIMATE FUNCTION FOR TESTING THE SIGNIFICANCE OF DIFFERENCES ACCORDING TO THE "STUDENT"-FISHER *t*-TEST.** Lyons, W. J. Textile Research J. *16:* 438–40. 1946.

An approximate function for applying the *t*-test in a new manner is suggested. This function is intended to express results and their significance in a simple, concise manner and to replace verbal expressions dependent on the personal interpretation of the experimenter. The method is considered suitable for use in textile research and other industrial laboratories. Equations for its derivation and application are given.

125. **A TENSIOMETRIC METHOD FOR EVALUATING SURFACE WETTABILITY BY MEASUREMENT OF THE CONTACT ANGLE.** Wakeham, Helmut; and Skau, E. L. J. Am. Chem. Soc. *67:* 268–72. 1945.

The basis for a simple contact angle measurement by means of an ordinary interfacial tensiometer in evaluating surface wettability is outlined and the method of measurement described. Contact angles corresponding to various tensiometer readings derived experimentally are shown to agree with values obtained from theoretical considerations. Application of the method to the measurement of contact angles of water on fabric and paper samples is illustrated, and precautions and sources of error are discussed.

26. **VOLUMETRIC DETERMINATION OF MOISTURE IN COTTON TEXTILES.** Keating, J. F.; and Scott, W. M. Am. Dyestuff Reptr. *31:* 308–10. 1942.

A titration method to determine moisture regain of cotton textiles is described. It is said to take about 30 minutes, compared with 5 to 7 hours required for the oven-drying method. Samples were weighed, cold-extracted with methanol for 10 minutes, and titrated with standard Fischer reagent. The method is considered as accurate as oven-drying, and the necessity for repeated weighings is eliminated.

Miscellaneous

1721. **EFFECTS OF ROLLER GINNING AND SAW GINNING ON PIMA S–1 COTTON.** Brown, J. J.; Howell, N. A.; and Ruppenicker, G. F., Jr. Textile Research J. *29:* 444–47. 1959.

A pilot-plant evaluation was made to compare the effects of roller ginning and saw ginning on the fiber, yarn, and fabric properties and the processing performance of Pima S–1 cotton. The fabrics were compared in the gray and after finishing. It was found that, within the limits of this study, the general processing efficiency of the roller-ginned cotton was better than that of the saw-ginned cotton. The method of ginning had no appreciable effect on the strength, uniformity, or elongation-at-break of combed yarns; but carded yarns spun from roller-ginned cotton were significantly stronger than those spun from saw-ginned stock. Combed yarns spun from the roller-ginned cotton were better in appearance than those spun from the saw-ginned stock. There were no significant differences in the physical properties of sewing thread produced from combed saw- or roller-ginned cotton. Fabrics produced from combed cotton ginned by both methods were approximately equal in tearing strength; but the saw-ginned cotton produced fabric that, in some cases, had a lower elongation and breaking strength. There were no significant differences in abrasion resistance between the fabrics before finishing, but the results for abrasion resistance of the finished fabrics were inconclusive. The fabric woven from the saw-ginned cotton contained considerably more neps than that woven from the roller-ginned cotton. Since this type of cotton is generally used for the production of fine-quality yarns and fabrics, it was concluded that saw-ginned extra long staple cottons would not be suitable for these uses. Also, because of the greater amount of waste during processing and the poorer spinning performance of the saw-ginned cotton, processing costs would be higher and would possibly offset any savings in ginning costs.

1348. **EFFECT OF COLLOIDAL SILICA TREATMENTS ON SIZING AND FINISHING CHARACTERISTICS OF COTTON YARNS.** Brown, H. M.; Langston, J. H.; and Murray, E. A. Textile Research J. *26:* 40–43. 1956.

Cotton in lap form was treated with a colloidal silica compound, and together with an untreated lap was processed into 15/1, 36/1, and 50/1 yarns. Samples of these yarns were used for control, for mercerizing, for bleaching, and for dyeing. Analyses of ash content were made on these four sets of samples. In addition, other samples of the yarns were used to assess the reaction to slashing, desizing, and abrasion. In general, the presence of colloidal silica on medium- and fine-carded yarns did not affect the operations of mercerizing, bleaching, and dyeing. Yarn strength differences between treated and untreated samples were of the same order after as they were before each of these chemical processes. Quantitative tests (ash-content analyses) to determine the effect of these processes on the permanence of the colloidal silica on the fiber were inconclusive.

1146. **EFFECT OF COLLOIDAL SILICA TREATMENTS ON COTTON PROCESSING CHARACTERISTICS AND YARN QUALITY.** Brown, H. M.; Langston, J. H.; and Rainey, W. T., Jr. Textile Research J. *25:* 462–71. 1955.

The study seems to show that with cotton having a considerable range in physical properties, the use of selected additives to increase the frictional characteristics of the fiber results in stronger, more uniform yarns, which can probably be processed with fewer ends down in spinning. Of the cottons evaluated, improvement is greatest for low-maturity, short-staple cotton. Machine settings to produce optimum evenness are not very different from those for untreated stock except that higher roll weighting seems to be required.

1067. **MEASUREMENT OF TRIBOELECTRIC RESPONSE OF RAW COTTONS.** Kirkwood, C. E., Jr.; Bellamy, O. H.; Kendrick, N. S.; and Brown, H. M. Textile Research J. *24:* 853–60. 1954.

By use of a novel commutator method, triboelectric potentials produced by rubbing cotton and various materials have been measured by comparison with known d. c. potentials. Results are given for fiberboard (phenolic resin laminate, fabric base), cork roller material, synthetic rubber roller material, Lucite, polystyrene, glass, and cellulose acetate sheet, used as rubbing materials on three varieties of cotton and on trash extracted from baled cotton. It does not seem that triboelectric methods can be used to distinguish between varieties of cotton, since generated voltages are so nearly the same. But, since there is a considerable difference between the voltage generated on cottons and that on trash by some rubbing materials (fiberboard and cork roller material), it seems that practical use may be made of triboelectric methods to separate the trash from cottons.

994. **DEVELOPMENTS IN EUROPEAN COTTON PROCESSING METHODS.** Rusca, R. A. Textile Research J. *24:* 589–91. 1954. Republished: Textile J. of Australia *29:* 1066–68. 1954.

European processing methods and machines are basically the same as ours, but the labor situation is different. Research in textile machinery seems concerned largely with developing new equipment, or modifying cotton machinery, specifically to process synthetic fibers. Opening rooms are more complicated than are average American opening rooms. One development on drawing frames is a new type of fluted roll that, combined with a slight tension draft in the middle drafting zone, reportedly produces a more uniform drawing sliver. Uniformity is improved also by using a 3-over-4 arrangement on drawing frames and combers. Some mills are changing to sliver lappers and 16-ends up bicoil drawing frames to eliminate one process of drawing or roving. Use of pneumatic and hydraulic systems in top-roll weighting is increasing.

1066. **MEASUREMENT OF DIELECTRIC CONSTANT AND DISSIPATION FACTOR OF RAW COTTONS.** Kirkwood, C. E., Jr.; Kendrick, N. S.; and Brown, H. M. Textile Research J. *24:* 841–47. 1954.

This research was part of a project on the cleaning and opening of cotton by the use of static electricity. Its objective was to determine whether there are differences between the dielectric constant and the dissipation factor for cottons and those for trash. By use of a suitable capacitance bridge and special condenser, the dielectric constant and dissipation factor at a frequency of 200 kc./sec. were measured for several varieties of cotton and for several types of trash removed during processing. Measurements were made at 70° F. and at relative humidities of 45, 55, and 65 percent. Results are in fair agreement with those obtained by other workers. Information of this type not only is useful in determining the electrical characteristics of cotton and trash, but also may be of value in determining the trash content of cotton, possibly leading to some method of separating the trash from the cotton.

863. **(1) RESEARCH TO INCREASE PROCESSING EFFICIENCY AND QUALITY OF COTTON PRODUCTS. (2) NEW DEVELOPMENTS IN THE INITIAL PROCESSING OF COTTON.** Rusca, R. A. (Two articles processed by National Cotton Council for inclusion in a pamphlet distributed at European Conferences.) June 1953. Also published in: Textile J. of Australia *28:* 1322–24. 1954; Federation of Master Cotton Spinners' Assoc., February 1954; Syndicat general de l'industrie cotonniere, July 1953; Associazioni Cotoniera Italiana, July 1953.

(1) Increasing quantities of mechanically harvested and other cottons of high trash content have led to improvement of textile cleaning equipment. Conventional opening-picking organizations are compared with modern opening-picking organizations that provide more effective cleaning with less fiber damage. Several new machines for blending, opening, and cleaning are described; and results of mill applications of this new equipment to processing American upland cottons are presented.

(2) Recent research studies in the field of cotton textile processing include the development of new guides for the proportionment of draft for long-draft roving systems; the determination of the relation between single- and ply-yarn twists and ply-yarn properties; the effect of fiber strength on ply-yarn properties; and the effect of fiber fineness on single-yarn strength. Examples are given of how yarn manufacturers can make practical use of this information.

849. **WARP KNITTING RESEARCH INDICATES HIGHER EFFICIENCY IN COTTON TRICOT KNITTING.** Shinn, W. E. The Knitter *16* (7): 1–5. 1952.

One of the principal causes of breakage of cotton yarns in tricot knitting was found to be imperfections in structure, such as slubs and soft spots. More careful selection and preparation of the yarn is recommended, and winders should be fitted with slub catchers adjusted to prevent passage of the slubs and soft spots. Speed of the machines had little effect on the number of end breaks, but the yarn twist did; and a twist multiplier of 3.5 gave the best results. Sley points result in better knitting, and light applications of adhesive type warp sizes greatly improve the knitting quality of cotton yarns. Results with different kinds of sizing adhesives are given. It is recommended that the fine-yarn spinning mills that supply the warp knitting mills with cotton yarns consider the installation of warpers and slashers so that sized warps can be made available to the knitting mills.

848. **THE EVALUATION OF TEXTILE SIZES.** King, D. E.; Weil, H. A.; Condo, F. E.; and Rutherford, H. A. Textile Research J. *22:* 567–73. 1952.

The effect of sizing mixtures on the slubby portions of a staple yarn was determined indirectly by the application of the size to a cotton roving and the subsequent testing of the roving for strength, ultimate elongation, and stiffness. In contrast to the methods that employ yarn as the base material for the application of the size, large differences between sizing mixtures were found by this procedure. The evaluation method investigated proved useful for the screening of sizes for knitting yarns that failed to give good knitting quality because of the presence of slubs.

690. **COTTON YARN SIZING MATERIALS, PREPARATION AND PRACTICES—A REVIEW OF THE LITERATURE.** Shinn, W. E.; Sink, C. B.; and Parker, M. E. Textile Bull. 77 (1): 81, 82, 84; Part I, Sizing Materials. (2): 57, 58, 60, Part II, Size Preparation. (4): 85, 86, 90–91, Part III, Sizing Practices. 1951.

Part I lists various materials used for sizing cotton yarns, with a brief description of their properties. A list of 27 literature references is included. *Part II* describes methods of preparing sizes on a plant scale, mentions a number of additives used to impart desired properties, and describes advantages and disadvantages of various methods. *Part III* discusses sizing practices and variables that influence sizing results. Size concentration, effect of stretch, drying temperatures, penetration, moisture content, and weight and covering of squeeze rolls are considered important. A number of conclusions drawn from reports in the literature are stated, and a list of 27 literature references appended.

515. **SURVEY OF TRICOT KNITTING LITERATURE (PARTS I—IV).** Shinn, W. E.; Sink, B. C.; and Parker, M. E. The Knitter *14* (5): 48, 50, 51; (6): 26, 28; (7): 36, 39, 40; (8): 40, 42, 44, 47. 1950.

Literature on tricot knitting is reviewed, and a list of references on the subject is given.

437. **DETECTION OF "HONEYDEW" ON RAW COTTON.** Stansbury, M. F.; and Hoffpauir, C. L. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–262, 4 pp. 1950. (Processed.)

A reliable qualitative test for the presence of honeydew on cotton has been developed. Honeydew is the sticky carbohydrate-containing excreta of aphids resulting from the partial digestion of plant sap on which these insects feed. The test is based on the alpha-naphthol (Molisch) reaction, as applied to an aqueous extract of honeydew-contaminated portions of the cotton. A control test is carried out on clean, uncontaminated portions of the sample. Ultraviolet fluorescence is often helpful in distinguishing between clean and contaminated portions. In applications of the test to several honeydew-contaminated cotton samples, the samples that gave the strongest tests contained the greatest amounts of reducing sugars, 0.48 and 0.40 percent. Samples picked after exposure to rain had considerable mold on the honeydew areas and gave only slight tests for honeydew. These samples also contained much less reducing sugars, apparently because of both the leaching by rain and the mold growth.

295. **BIBLIOGRAPHY ON HIGH-FREQUENCY DIELECTRIC HEATING.** Rusca, R. A. American Institute of Engineers, August 1947.

This bibliography, although admittedly not complete, is one of the most comprehensive published on the subject thus far. Literature citations and patents have been classified as "Domestic" and "Foreign," and are arranged alphabetically by title in these two categories. An author index is included.

188. **DIELECTRIC HEATING ANALYZED FOR TEXTILE APPLICATIONS.** Rusca, R. A. Textile World *96* (5): 118–21, 212, 217, 220, 230. 1946.

Fundamental theory, applicable formulas, and limiting conditions in the application of dielectric heating are discussed. A comparison is made of the electronic methods of generating high-frequency power; and the results of some preliminary research on dielectric heating of cotton textiles are reported. It is pointed out that, while at present the economics of the process compares unfavorably with that of other methods of drying textiles, continued research and development may well overcome this limitation.

MISCELLANY

Carpet Cleaning

1503. **ON-LOCATION CLEANING OF COTTON CARPETING. PART II. DEVELOPMENT OF AN IMPROVED SCRUBBING MACHINE.** Bixler, M. E. National Rug Cleaner *30* (8) : 9, 19. 1957.

The development of an improved scrubbing machine is described, and major features in the design of the machine are outlined. A new procedure and new equipment, based on a commercial size rotary scrubber developed to solve problems, are described.

1502. **ON-LOCATION CLEANING OF COTTON CARPETING. PART I. CARPET SOILING AND DETERGENT STUDIES.** Studer, C. W. National Rug Cleaner *30* (8) : 8, 10, 12, 19. 1957.

Problems most frequently encountered by professional carpet cleaners are presented. The requirements of a detergent for cotton carpets are delineated and steps to formulate an excellent detergent described. Accelerated natural soiling techniques were established for obtaining samples for investigation. A saturation plateau was observed on soiled cotton carpeting, and this condition was established on all samples used in scrubbing tests. A new method was developed for determining suds wetness characteristics of a detergent. The most satisfactory detergents were nonionic dry powders, each built with sodium tripolyphosphate, carboxymethylcellulose, and a small amount of alkyl aryl sulfonate.

Soiling of Fiber and Fabric

1591. **THE SURFACE OF COTTON FIBERS: IV. DISTRIBUTION OF DRY SOIL.** Tripp, V. W.; Moore, A. T.; Porter, B. R.; and Rollins, M. L. Textile Research J. *28:* 447–52. 1958.

The location of soiling agents such as colloidal and activated carbon, a floor soil, a synthetic soil, and a clay on gray and modified cotton fabrics soiled under controlled conditions was determined by light and electron microscopical examination. Gross and fine geometry of fabric and fiber play a major role in determining the distribution of soil in most cases. The mechanical entrapment of soil particles and agglomerates between fibers near the surface of the fabric is repeated in the accumulation of soil in the natural or induced irregularities of the native and modified fiber surfaces. The presence of soft films on the fiber surface extends the quantity of soil and its distribution. Sorption of the soil particles on apparently smooth areas of the fiber also occurs to a significant extent.

1509. **THE SURFACE OF THE COTTON FIBER—PART III: EFFECTS OF MODIFICATION ON SOIL RESISTANCE.** Porter, B. R.; Peacock, C. L.; Tripp, V. W.; and Rollins, M. L. Textile Research J. *27:* 833–45. 1957.

Experiments designed to complement microscopical studies and to attempt a practical evaluation of the effectiveness of various agents that impart resistance to dry soil are reported. Various methods of applying soil to fabric were evaluated, as was the effectiveness of a number of soil retardants. Soils included carbon blacks of a range of particle sizes, a natural clay, and a synthetic soil whose formula approximated the composition of natural soil containing fatty materials. Fabrics were also soiled by foot traffic on the floor. Results were interpreted from reflectance data and from radioactive tracer assays of weight of soil takeup. In attempting to elucidate the mechanism of dry soiling, the effects of textile construction, electrical charge on the fiber, particle size of soil as related to topography of fiber surface, surface hardness, reducing surface roughness, and lowering surface energy were considered. Soil takeup is directly related to specific surface. Gray cotton is slightly more resistant to soil than is bleached cotton; and increased smoothness of fiber, even to complete obliteration of native rugosities, did not necessarily impart soil resistance to cotton fabrics. The most successful types of antisoiling agents for dry soils appear to be colloidal particulate applications such as silica or alumina, and additive finishes that lower surface energy of the fiber. Only a few of the typical commercially available soil retardants were used in these studies. The project was a short-term one, and the experiments were designed to study the mechanism of soiling cotton textiles that would be subject to in-place cleaning. Many new soil retardants were marketed after the experiments had been initiated.

1425. **SOIL-RESISTANT FINISH FOR COTTON FABRICS.** Tripp, V. W.; Clayton, R. L.; and Porter, B. R. Textile Research J. *27:* 340–42. 1957.

Use of perfluorodecanoic acid to increase the resistance of cotton to soiling has been investigated. In laboratory experiments this gave good resistance to dry and greasy soils without visible effect on the topography of the fiber or appreciable change in the hand of the fabric. Several different methods of applying the perfluorodecanoic acid were tried. Addition of sodium acetate was found to reduce to a minimum the acid tendering that accompanies drying at elevated temperatures. While the finish is removed by water, use of other compounds in connection with the process increases water repellency.

980.1. **THE THEORY OF SOIL-FIBER COMPLEX FORMATION AND STABILITY.** Compton, J.; and Hart, W. J. Textile Research J. *24:* 263–64. 1954.

Theories concerning the mechanisms of soil deposition and retention on fiber surfaces that have resulted from work during the past 4 years are summarized. Factors governing the rate and probability of the formation of a soil-fiber complex, and the nature of the bond between soil particles and the fiber surface, or factors controlling the stability of the soil-fiber complex, are considered. There are three possible binding mechanisms for a soil-fabric complex: Macro-occlusion (entrapment of particles in the intrayarn and interyarn spaces); micro-occlusion (entrapment of particles in the irregularities of the fiber surfaces); and sorptive bonding of the soil to the fiber (by van der Waals' or coulombic forces). The importance of micro-occlusion as a factor has been hitherto neglected. The stability of the soil-fabric complex (basic problem of detergency) depends on the nature of the bonding mechanism or mechanisms. The process of drying—called "secondary deposition"—greatly increases binding of soil to fiber by one or more of the modes mentioned.

911. **SOILING AND SOIL RETENTION IN TEXTILE FIBERS III: SUSPENDING POWER OF SURFACTANTS.** Compton, J.; and Hart, W. J. Ind. Eng. Chem. *45:* 597–602. 1953.

Soil is redeposited during laundering through distribution of suspended soil particles between the liquor penetrating the fabric and the remainder of the bath and through attachment of soil particles to the fiber surfaces. In previous work a chopped-fiber technique was developed that permits soil redeposition studies for the first time without the complicating factor of fabric construction. The mechanism of soil redeposition on fabrics was analyzed and was correlated with the suspending power of surface active substances (surfactants). A rapid quantitative method for the determination of suspending power was given and the behavior of a wide range of surfactant-soil-fiber systems was studied. Results and techniques should be of interest to the textile and detergent industries.

915. A STUDY OF SOILING AND SOIL RETENTION IN TEXTILE FIBERS. VI. THE EFFECT OF YARN AND FABRIC STRUCTURE IN SOIL RETENTION. Hart, W. J.; and Compton, J. Textile Research J. *23:* 418–23. 1953.

Necessary conditions for applying the Kubelka-Munk equation to fabric-soil systems to determine soil content from reflectance measurements have been given, namely, uniformity of particle distribution in the fabric, random orientation of the soil particles, and known or constant specific absorbency of the soil. The phenomenon of macro-occlusion, or interfiber and interyarn entrapment of soil particles in fabric structure, has been studied for several types of fibers and fabrics and found to be a major factor in soil retention. It is suggested that soil particle macro-occlusion in soiled fabric structures is largely responsible for difficulty in removing soil during laundering and in obtaining consistent, precise detergency data.

914. PRIMARY DEPOSITION OF GREASE-FREE CARBON BLACK SOIL ON VARIOUS TYPES OF TEXTILE FIBERS. Hart, W. J.; and Compton, J. Textile Research J. *23:* 164–69. 1953.

For cotton, silk, wool, linen, rayon, nylon, and Fortisan, soil-fiber complexes with grease-free carbon blacks have been studied. Varying widely for the different fibers are the percent distribution of total surface occupied by crevices of varying diameter; the rate of primary deposition of soil; and the suspending power of different surfactants for a given soil. Synergism of surfactants appears to be a proper characteristic of the entire soil-fiber-surfactant system, rather than one inherent in a given additive or surfactant combination. Each of the soil-fiber complexes studied appears to be micro-occlusive and shows a zero temperature coefficient of stability. The application of a small quantity of energy to the systems, in the form of mechanical agitation, resulted in a relatively large decrease in soil retention by the fiber; whereas the introduction of a large quantity of energy as thermal energy had little or no effect.

912. A STUDY OF SOILING AND SOIL RETENTION IN TEXTILE FIBERS. IV. GREASE-CARBON BLACK SOIL-COTTON FIBER SYSTEMS. Compton, J.; and Hart, W. J. Textile Research J. *23:* 158–63. 1953.

The general system grease-carbon black soils-cotton fiber has been studied. Sorptive binding of soil to fiber occurs in such systems by a grease layer that binds the soil particles to the fiber surface. Evidence of this is the effect of detergents and solvents on the grease-soil-fiber bond in reducing the tenacity with which soil is held. Soil particles may be attached to the fiber surface by sorption, micro-occlusion, or both. Sorptive binding of soil particles on a greasy fiber surface does not appear to occur during the primary stage of soil deposition, but only as water is removed from the system. Crevice area distribution and soiling rate curves indicate that the addition of oils and greases up to 5 percent of the weight of the fiber does not markedly alter the surface contour of the fiber in the submicroscopic range of 25 to 110 μ.

850. IMPROVEMENT OF COTTON CLOTH IN RESISTANCE TO SOILING AND IN EASE OF WASHING. Utermohlen, W. P., Jr.; Ryan, M. E.; and Young, D. O. Textile Research J. *21:* 510–21. 1951. Republished: Textile J. of Australia *26:* 1115–18, 1120, 1122–23. 1952.

The general problem of producing resistance to soiling in cotton textiles is presented, and the effects of a number of treatments on the ease of soil acquisition by cotton cloth and on the ease of soil removal from the soiled cloth by washing are described. Of the treatments employed, those that altered the electrical charge on the cloth by introducing acidic groups appeared to have the most favorable general effect in increasing soiling resistance and ease of soil removal. A partial-acetylation treatment was noticeably effective in increasing resistance to dry soiling.

638. SOILING AND SOIL RETENTION IN TEXTILE FIBERS. PRIMARY DEPOSITION OF GREASE-FREE CARBON BLACK ON CHOPPED COTTON FIBERS. Hart, W. J.; Compton, Jack. Ind. Eng. Chem. *44:* 1135–41. 1952.

This work is a continuation of the basic study of the formation and hiding of soil-fiber complexes. A method for studying the kinetics of soil deposition has been developed and a number of variables of importance to soil-fiber systems have been investigated, including concentration of soil, concentration of fiber, intensity of agitation during soiling, effects of surfactants, and the thermal coefficient of complex formation and stability. A qualitative mechanism for soil-fiber complex formation is discussed, and it is shown that all results tend to confirm the geometric mode of particle hiding previously suggested.

692. SOILING AND SOIL RETENTION IN TEXTILE FIBERS. COTTON FIBER-GREASE-FREE CARBON BLACK SYSTEMS. Compton, Jack; and Hart, W. J. Ind. Eng. Chem. *43:* 1564–69. 1951.

A fundamental knowledge of the specific properties of cotton fibers, yarns, and fabrics responsible for the formation and stability of soil-fiber complexes is essential to the development of treatments designed to increase soil resistance and ease of soil removal. This investigation is concerned with the interaction of cotton fibers, reduced in length to 0.1 to 1 mm. to avoid variables arising from yarn and fabric structure, with aqueous dispersions of carbon black soils in the primary particle size range of 10 to 100 microns under various conditions. It was found that surfactants and electrolytes affect the formation of such soil-fiber complexes but not the stability of these complexes once they are formed. The factor primarily responsible for the formation and stability of the soil-fiber complexes is micro-occlusion, or geometric binding, of the soil particles by the microscopic and submicroscopic crevices in the fiber surface.

517. IMPROVEMENT OF THE RESISTANCE OF COTTON CLOTH TO SOILING. Utermohlen, W. P., Jr. Am. Dyestuff Reptr. *39:* 262–64. 1950.

The effect of a number of treatments on the ease of soil acquisition by cotton cloth and on the ease of soil removal from the cloth by washing has been studied. Among the treatments employed were the following: Various amounts of moisture; various amounts of starch; cationic and anionic softening agents; durable and nondurable hydrophobic finishes; prepolymerized vinyl-emulsion polymers; urea-formaldehyde condensates polymerized in the cloth; treatments such as partial acetylation that produce chemical alterations in the cotton cellulose. Cloths so treated were soiled with several kinds of pigment from liquid dispersions or in a dry state and washed. Effects of these treatments on the ease of soiling and the ease of soil removal are presented and briefly discussed. Those that alter the electrical charge on the cloth by introducing acidic groups appeared to have the most favorable general effect in increasing soil resistance and in ease of soil removal. Partial acetylation was particularly effective in increasing resistance to dry soiling.

578. **CMC MAKES CLEANER COTTON.** Strickland, W. B. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 453–54.

A simple washtub treatment for cotton goods that speeds soil removal in the tub and leaves a soil-resistant finish is described. It consists merely of adding to the water each time the goods are washed a solution of a commercially available compound, carboxymethyl cellulose, known as CMC. Examples are given of the effectiveness of the treatment. The procedures of application were developed in a Research and Marketing contract research project conducted at the Institute of Textile Technology, Charlottesville, Va., supervised by the Southern Regional Research Laboratory.

Tire Cord

630. **EFFECT OF A DYNAMIC FATIGUE TEST ON THE MECHANICAL PROPERTIES OF TIRE CORDS.** Grant, J. N.; Couturier, G. M.; and Rhodes, M. W. Textile Research J. *21:* 867–75. 1951.

Changes in the mechanical properties of cords subjected to dynamic fatigue were measured for cotton, mercerized cotton, and rayon tire cords. These data were obtained by use of an instrument that subjected the cords under tension to localized dynamic forces under controlled atmospheric conditions. The forces, when observed on an oscilloscope screen, varied during the flex cycle. Flex life and ultimate elongation were cumulative, regardless of whether the cords were fatigued continuously or were allowed to relax with or without static tension between periods of flexing. Calculated activation energies for fatigue failure were less than those for heat degradation. From the differences in properties, a qualitative evaluation of tire cord behavior could be made.

641. **THERMAL DEGRADATION IN TIRE CORDS. PART II. EFFECTS OF MODULUS, TOUGHNESS, AND DEGREE OF RESILIENCE.** Tripp, V. W.; Mares, Trinidad; and Conrad, C. M. Textile Research J. *21:* 840–46. 1951.

Cotton and rayon tire cords from four stages of the manufacturing process were heated from 16 to over 1,000 hours at temperatures ranging from 230° to 302° F., to test the effect on average modulus, breaking toughness, and degree of resilience at 50 percent of their breaking loads. The modulus and breaking toughness of all the cords were decreased. The effects of the heat treatments were progressive with time of heating and were accelerated by raising the temperature. The degree of resilience of the cords was not significantly affected, even after severe losses of strength and toughness. The cords that had been vulcanized in rubber were less affected than were those that had been unprocessed, dipped, or calendered. Cords that had been run to failure in a wheel test showed increased modulus and decreased toughness.

625. **THERMAL DEGRADATION IN TIRE CORDS. PART I. EFFECTS ON STRENGTH, ELONGATION, AND DEGREE OF POLYMERIZATION.** Conrad, C. M.; Tripp, V. W.; and Mares, Trinidad. Textile Research J. *21:* 726–39. 1951.

Thermal degradation in cotton and rayon tire cords before and during processing into tires has been studied. Also, tests were made on the cords from representative cotton and rayon tires that had been operated to failure on a National Bureau of Standards test wheel. The study showed that high temperatures during vulcanization should be minimized; that heating at 230° F. or above causes permanent progressive degradation to both cotton and rayon cellulose; that small amounts of chain breakage may have effects on physical properties of tire cords out of proportion to their relative magnitudes; and that some of the components of some of the treating baths—probably the alkali in the dip—may be detrimental to the life of the cords. These findings may be of interest to the tire industry.

523. **ON PRECONDITIONING COTTON YARN AND TIRE CORD BEFORE TESTING BREAKING STRENGTH AND ELONGATION-AT-BREAK.** Lewis, W. S. Textile Research J. *21:* 256–58. 1951.

Tests were made to learn to what degree breaking strength and elongation-at-break of cotton yarns and tire cord are influenced by prior moisture history, and whether or not preconditioning before exposure to the standard atmosphere of 65 ± 2 percent r.h. at 70° ± 2° F. should be required. Preconditioned cotton yarns and tire cord showed no significant differences in breaking strength or elongation-at-break that could be attributed to their moisture regain before their exposure in the standard atmosphere. The preconditions were approximately 29 percent r.h. at 96°, 60 percent r.h. at 78°, and 80 percent r.h. at 70°. It is concluded that for such materials under the usual test conditions, where moisture regain is within the 4 to 10 percent observed in the samples tested, preconditioning so that moisture equilibrium in the standard atmosphere is approached from a lower regain is not necessary before determining breaking strength and elongation-at-break.

328. **A MICROSCOPICAL TECHNIQUE FOR DETERMINING LATEX DISTRIBUTION IN TIRE CORDS.** deGruy, I. V.; and Rollins, M. L. Textile Research J. *18:* 371–73. 1948.

An investigation of latex-dipped tire cords has resulted in the development of a simple microscopical technique that may be of interest in evaluating different lattices for cord dipping or various cord constructions for latex adhesion. The procedure involves differential staining and cross sectioning of the cord to demonstrate the location of latex solids *in situ*. A detailed description of the method is accompanied by photomicrographs illustrating the results obtained.

306. **HYSTERESIS, ELASTIC MODULUS, AND GROWTH OF TIRE CORDS UNDER COMPARABLE LOADS.** Honold, Edith; and Wakeham, Helmut. Ind. Eng. Chem. *40:* 131–34. 1948.

The authors believe that any investigation of tire cords aimed at improving failure resistance should include tests under conditions as nearly like those of actual service as possible. In an effort to arrive at the best laboratory conditions for making such tests, consideration was given to the fact that in actual service tire cords frequently get very hot yet retain a moderate amount of moisture. Measurements were made of the hysteresis, elastic modulus, total growth, and a growth rate of 14 typical tire cords of native cotton, mercerized cotton, rayon, and nylon at three conditions of moisture and temperature. The data are summarized in three tables and two graphs. Results of the study are evaluated, and some possible significances of the properties measured are discussed.

243. MOISTURE TRANSFER TO AND FROM TIRE CORDS ENCASED IN GR–S. Lyons, W. J.; Ziifle, H. M.; Nelson, M. L.; and Mares, Trinidad. India Rubber World *116:* 199–204, 207. 1947.

Observations of moisture regain at room temperature have been conducted on test pieces of GR–S tire-carcass materials into which cotton and rayon tire cords had been vulcanized. GR–S test pieces containing no fabric were used as controls. The results, which are tabulated and shown graphically, permit the following conclusions: (1) The 2 to 4 percent of original moisture in a cord prior to its use in a tire cannot be regarded as a permanent condition; (2) in tires with outer layer of rubber in the sidewalls $\frac{1}{16}$ inch thick, moisture in the outer plies of a cotton fabric may be expected to amount to 6 or 7 percent after 6 months of actual service in a damp climate; (3) cotton cords thoroughly embedded in rubber absorb moisture, at normal temperatures, very slowly above about 6-percent regain; (4) if breaks occur in the outer rubber, moisture regain may rise to 12 or 14 percent; (5) under comparable conditions, the moisture in rayon fabrics can be expected to be from 20 to 100 percent greater than that in cotton fabrics; and the time-average moisture regain of the rayon fabrics through a cycle of exposures at various humidities would be about three times as great.

272. EFFECT OF ALTERNATE HEATING AND COOLING ON THE BREAKING STRENGTH AND ELONGATION OF COTTON AND RAYON TIRE CORDS. Lewis, W. S. Textile Research J. *17:* 431–37. 1947.

One mercerized and two unmercerized cotton tire cords and three commercial rayon tire cords were subjected to alternate heating and cooling. The effects on tenacity (grams per denier) and elongation were determined at the end of 1, 24, 36, and 48 heating periods. Tests were conducted on the cords in the oven-dry state and also after conditioning in a standard atmosphere of 65-percent relative humidity at 70° C. The mercerized cord showed the greatest resistance to change in tenacity and was generally followed by one of the rayons. Under standard testing conditions, the two unmercerized cords retained tenacity better than the two other rayons; but this order was reversed under oven-dry conditions. The rayons exhibited higher initial elongations and, with one exception, greater losses on heating and cooling than did the cottons. The two methods of measuring elongation gave a slightly different order of rankings of the cords. The degrees of polymerization of the cellulose changed after 48 heating and cooling cycles from 2,400 to 385 for the Wilds 13 unmercerized cord; from 2,360 to 310 for the mercerized cord; and from 430 to 129 for the rayon cords.

242. ENDURANCE OF COTTON TIRE CORDS AND FIBERS UNDER STATIC TENSIONING. Karrer, Enoch; Grant, J. N.; and Orr, R. S. Textile Research J. *17:* 314–22. 1947.

For the fuller interpretation of tests of the endurance of tire cords under conditions of flexing, tests of endurance under static tensioning were made on the following types of tire cords: Regular commercial rayon and cotton cords; experimental cotton cords manufactured and mercerized at the Southern Laboratory; and mercerized and unmercerized cotton cords from a selected variety manufactured on standard commercial equipment. The curves of relation between the tensioning load and the logarithm of the time elapsing under tension before rupture were plotted from data obtained in typical observations made over a range of tensioning load of from 50 to 90 percent of the previously determined tensile strength of the cords. The relation at room temperature was shown to be linear in cotton cords; but this simple logarithmic relation was not found in the rayon cords. In mercerized cotton cords at elevated temperature, moisture equilibrium must be approached to obtain a linear relationship. Since the question arises as to whether rupture consists merely of the movement of fiber past fiber or of the movement of structural elements within the fiber or filament, the endurance of single cotton fibers and rayon filaments under static tensioning was measured. The single fiber or filament relation was found to be very much the same as that of the corresponding cords. Rupture in the single cotton fiber and the rayon filament, as well as in the cords, appeared to be the terminal condition of a phenomenon of flow of the micro-elements of the fibers themselves rather than one of movement of fiber past fiber.

239. STRESS RELAXATION OF COTTON AND RAYON CORDS AT CONSTANT LENGTH. Burleigh, E. G.; and Wakeham, Helmut. Textile Research J. *17:* 245–55. 1947.

The Tobolsky-Eyring reaction-rate theory of elastoviscous behavior has been applied to stress relaxation at constant length for cotton and rayon cords. The apparatus used is described and illustrated. Typical relation curves at different conditions of humidity and temperature are given. The data obtained were utilized in evaluating the molecular constants in the Tobolsky-Eyring theory. Results suggest that the mechanism of fiber breakage is one involving slippage of the cellulose chains with respect to each other rather than rupture of primary valence bonds. For the particular case of stress relaxation at 100-percent relative humidity, the process has been resolved into two components, the more rapid of which appears to be the limiting case in which cellulose chains are flowing as individuals.

210. COTTON TIRE CORD: PRESENT AND FUTURE USE IN TIRES. DuPré, Mason. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–130, 8 pp. 1946. (Processed.)

A brief history of the development of pneumatic tires from the standpoint of cotton up to the time rayon was introduced commercially in 1937, is followed by a discussion of the present competitive status of cotton in this use. The current abnormally high demand for all suitable types of cords is masking the effects of various competitive factors involved, but in the long run the tire cord market will be divided on the basis of which fiber offers the greatest useful mileage-per-dollar value for different classes of tire service.

189. MOISTURE RELATIONS OF TIRE CORDS IN TIRES. Wakeham, Helmut; Honold, Edith; and Portas, H. J. India Rubber World *113:* 659–62, 721. 1946.

An experimental technique is described for calculating the moisture content of cords in tires. It consists principally of removing the cord and weighing without permitting appreciable moisture exchange with the air. The effects of storage, of exposure to different temperatures and humidities, and of wheel test operations are determined. Environmental condition appears to have the most determined effect. In a humid climate, values would be expected to be rather high. Even when the tire is operated under conditions conducive to high tire temperatures, considerable time is required for the cord to undergo appreciable moisture loss through the rubber.

208. **STUDY OF CHEMICAL DEGRADATION OF CELLULOSE IN COTTON TIRE CORDS AS A RESULT OF ROAD SERVICE AND WHEEL TESTING CARRIED TO FAILURE.** Conrad, C. M.; Lyons, W. J.; and Tripp, V. W. Textile Research J. *16:* 324–28. 1946.

To determine whether and to what extent chemical degradation occurs in the cellulose of 7.50–20 cotton tire cords in service, cuprammonium fluidity measurements were made on cords taken from eight tires operated to failure on the Normoyle, Tex., road course, and on a National Bureau of Standards "wheel." The chemical degradation caused by operation of these tires to failure was, in general, minor. Degradation increased with the increase in percentage of normal load during road operation. Tires operated on the "wheel" showed considerably greater degradation than did those operated on the road course. Appreciable degradation of the cellulose occurred during the manufacture of the tires.

215. **HYSTERESIS AND RELATED ELASTIC PROPERTIES OF TIRE CORDS.** Wakeham, Helmut; and Honold, Edith. J. Appl. Phys. *17:* 698–711. 1946.

A method of evaluating mechanical hysteresis, elastic modulus, elongation, and growth rate of a yarn or cord subjected to cyclic loads in a fatigue test is described. The test is applied to seven typical tire cords: One nylon, two rayon, and four cotton cords including both high- and low-stretch cords. Results show the effect of cycle number, moisture content, temperature, and load range on elastic properties. The influence of cyclic loading on the stress-strain curve is also discussed.

131. **STUDY OF THE "H" TEST FOR EVALUATING THE ADHESIVE PROPERTIES OF TIRE CORD IN NATURAL AND GR–S RUBBERS.** Lyons, W. J.; Nelson, M. L.; and Conrad, C. M. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–99. 56 pp. 1945. (Processed.) Republished: India Rubber World *114:* 213–17, 219. 1946. (Abridged.)

The characteristics of the "H" test for measuring the adhesion of tire cords to natural and GR–S rubbers and its reliability are discussed. A method that provides a means of holding uniform the significant factors is proposed for conducting the test. The major groups of influences considered were experimental conditions, time, rubber-stock, and cord. It was found that the four most important physical conditions of the test were: Testing temperature, presence of the sheath around the cord, gage of the cord, and speed of the pulling clamp.

186. **THE GENERAL RELATIONS FOR FLOW IN SOLIDS AND THEIR APPLICATION TO THE PLASTIC BEHAVIOR OF TIRE CORDS.** Lyons, W. J. J. Appl. Phys. *17:* 472–82. 1946.

Two equations, one for creep and one for relaxation, found to hold more or less well with various plastic solids are applied with modification to the study of creep and relaxation of tire cords. While they cannot be used validly to compute strains or stresses for periods 100 or 1,000 times as long as that over which the constants were evaluated, these equations together provide the framework of what may be regarded as the normal flow behavior of amorphous solids. In view of their wide verification, use of these two equations as the basis for more or less standardized tests of creep and relaxation in cords and in yarns would appear feasible.

136. **A COMPARISON OF SOME ELASTIC PROPERTIES OF TIRE CORDS.** Wakeham, Helmut; Honold, Edith; and Skau, E. L. J. Appl. Phys. *16:* 388–401. 1945.

The elastic properties of four commercial and five experimental tire cords are compared over wide ranges of loads, temperatures, and moisture contents. The effect of temperature on elongations with various static loads was investigated and the influence of moisture content on the results pointed out. The partial recovery and growth of rayon and cotton cords subjected to cyclic loadings are compared. A hysteresis test is described in which the energy loss per cycle of loading and unloading may be calculated.

133. **EFFECT OF TIRE CORD UNIFORMITY ON THE STRENGTH OF TIRE FABRICS.** Philipp, H. J. Textile Research J. *15:* 397–402. 1945.

Various methods of estimating the effective strength of tire cord are discussed. These methods show a satisfactory degree of correlation. A formula is presented that permits a simple calculation of the effective cord strength from the coefficient of variation of cord strength. The calculated effective cord strength of several rayon and cotton tire cords, estimated by different methods, is tabulated.

134. **CONTROL OF ELONGATION IN HIGHLY STRETCHED COTTON TIRE CORD.** Philipp, H. J.; and Conrad, C. M. J. Appl. Phys. *16:* 32–40. 1945.

To discover the best combination of factors known to improve the strength of tire cords, stretching treatments involving various combinations of tension, heat, and moisture were applied to cords of several different constructions made from five cotton varieties. It was found that all these treatments increased the strength of the cords from 35 to 50 percent but reduced their elongation at 10 pounds to an unfavorable degree. A dual-stretching method, consisting of hot wet stretching followed by cold wet treatment and drying under controlled tension, was then devised that permits retention of most of the increased strength with satisfactory improvement of the elongation.

135. **APPLICATION OF THE TORSIONAL HYSTERESIS TEST TO TIRES.** Wakeham, Helmut; and Honold, Edith. India Rubber World *113:* 377–81. 1945.

The torsional hysteresis test of Mooney and Gerke applied to sections cut from tires permitted evaluation of the hysteresis properties of the rubber and cord combination existing in fabricated tires. The hysteresis of carcass sections containing the cord is influenced by moisture content, temperature, and time of heating of the section. There was evidence that the presence of the cord is responsible for the higher hysteresis observed for carcass sections when they are compared to all-rubber samples such as those taken from the tread of the tire. The hysteresis of tires was found to increase with mileage, and the increase was greater for tires in the front than for those in the center and rear positions.

PATENTS

Chemical Modification and Treatment

1904. **REACTION PRODUCTS OF 1-AZIRIDINYL COMPOUNDS WITH COMPOUNDS CONTAINING ACTIVE METHYLENE GROUPS.** Reeves, W. A.; Chance, L. H.; and Drake, G. L., Jr. U.S. Pat. No. 2,917,492, December 15, 1959.

Resinous compositions produced by the reaction of compounds that contain two or more 1-aziridinyl groups attached directly to nonmetallic atoms with compounds that contain two or more active hydrogen atoms attached to carbon atoms. These materials are used in the plastics and coating arts; they are flame resistant and, when used as a coating or impregnant, reduce the flammability of the coated or impregnated article.

1903. **PROCESS FOR THE PRODUCTION OF CELLULOSIC TEXTILES WITH PERMANENT CREASES AND IMPROVED SOIL AND ABRASION RESISTANCE.** Reinhardt, R. M.; Mazzeno, L. W., Jr.; and Reid, J. D. U.S. Pat. No. 2,917,412, December 15, 1959.

A process for treating textiles to produce a finish that will cause the material to retain permanent creases, to exhibit wrinkle-resistance, and to have dimensional stability and resistance to soiling. The textile is treated with a water emulsion containing dimethylol cyclic ethylene urea, emulsified polyethylene, a latent acid catalyst, and an emulsifier.

1902. **METHYLOL-PHOSPHORUS MODIFIED EPOXY RESINS.** Bullock, A. L.; Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,916,473, December 8, 1959.

Modified epoxy resins wherein phosphine oxide or phosphonium salt groups are combined into the molecules of the glycidyl polyethers by means of additional ether linkages. Materials treated with these products exhibit resistance to burning.

1901. **AZIRIDINE-CARBOXYLIC ACID ESTERS.** Reeves, W. A.; and Drake, G. L., Jr. U.S. Pat. No. 2,915,480, December 1, 1959.

New synthetic resinous materials useful in the plastics and coating arts for coating, laminating, impregnating, and molding; polymeric materials produced by reacting compounds that contain two or more 1-aziridinyl groups with carboxylic acid compounds.

1900. **PHOSPHORUS CONTAINING POLYESTERS AND METHOD FOR THEIR PRODUCTION.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,913,436, November 17, 1959.

Polymers composed of polyesters of carboxylic acids and polyhydric phosphorus compounds of the type, tetrakis(hydroxymethyl)phosphonium chloride, and tris (hydroxymethyl)phosphine oxide.

1899. **AZIRIDINE-PHENOLIC POLYMERS.** Reeves, W. A.; Guthrie, J. D.; and Chance, L. H. U.S. Pat. No. 2,912,412, November 10, 1959.

New synthetic polymers, the processes for their production and their use, and the polymers made by reacting compounds containing at least two 1-aziridinyl groups attached to nonmetallic atoms with phenolic compounds.

1898. **FLAME RESISTANT ORGANIC TEXTILE AND METHOD OF PRODUCTION.** Drake, G. L., Jr.; Reeves, W. A.; and Chance, L. H. U.S. Pat. No. 2,911,325, November 3, 1959.

Flameproof textiles produced by treatment with mixed polymers made by reacting 1-aziridinyl phosphine oxide or sulfide with methylol phosphorus compounds or with compounds produced by reacting methylol phosphorus compounds with trivalent nitrogen compounds.

1897. **FLAME- AND CREASE-RESISTANT TEXTILES FROM AZIRIDINYL CARBOXYALKYLCELLULOSE.** Reeves, W. A.; Guthrie, J. D.; and Drake, G. L., Jr. U.S. Pat. No. 2,906,592, September 29, 1959.

Flame-resistant, crease-resistant textiles prepared by treatment with the reaction product of compounds containing two or more aziridinyl groups and carboxyalkylcellulose.

1896. **POLYMERS MADE FROM 1-AZIRIDINYL PHOSPHENE OXIDES AND SULFIDES AND FLAME-RESISTANT ORGANIC TEXTILES.** Chance, L. H.; Drake, G. L., Jr.; and Reeves, W. A. U.S. Pat. No. 2,901,444, August 25, 1959.

New phosphorus and nitrogen containing polymers, the process for their production, and processes for employing the polymers in the flameproofing of textiles.

1803. **COMPOSITION COMPRISING NITRILO METHYLOL-PHOSPHORUS-POLYMER AND ORGANIC TEXTILES FLAME-PROOFED THEREWITH.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,892,803, June 30, 1959.

Polymers produced by condensation or esterification reactions between methylol phosphorus compounds (THPC and/or THPO) and nitrilo compounds (compounds with a molecular weight below 800 and containing at least one nitrogen atom having attached thereto hydrogen atoms of CH_2OH groups). Textile fabrics treated with solutions of the prepolymer ingredients exhibit no afterflame properties (i.e., do not continue to burn following removal of the igniting flame).

1802. **FLAME RESISTANT ORGANIC TEXTILES AND METHOD OF PRODUCTION.** Chance, L. H.; Drake, G. L., Jr.; and Reeves, W. A. U.S. Pat. No. 2,891,877, June 23, 1959.

A method for rendering textile materials flame resistant. The homopolymers of 1-aziridinyl phosphine oxide or 1-aziridinyl phosphine sulfide are deposited on the surfaces or in the interstices of the textile materials where they resist removal by laundering and chemical treatments.

1800. **PHOSPHORUS CONTAINING AZIRIDINYL-AMINE POLYMERS AND FLAME RESISTANT ORGANIC TEXTILES.** Reeves, W. A.; Chance, L. H.; and Drake, G. L., Jr. U.S. Pat. No. 2,889,289, June 2, 1959.

Polymeric compositions produced by reacting 1-aziridinyl phosphine oxide and/or sulfide with amino compounds (compounds containing a trivalent nitrogen atom to which CH_2OH groups and/or H atoms are attached). Textiles treated with these polymeric compositions exhibit flame, shrink, rot, and mildew resistance.

1799. **AZIRIDINE-METHYLOLPHOSPHORUS POLYMERS AND FLAME RESISTANT ORGANIC TEXTILES.** Drake, G. L., Jr.; Reeves, W. A.; and Chance, L. H. U.S. Pat. No. 2,886,539, May 12, 1959.

Polymers produced by reacting 1-aziridinyl phosphine oxide and/or sulfide with a methylol phosphorus compound (THPC and/or THPO). Textiles treated with these polymeric compositions exhibit flame, shrink, rot, and mildew resistance.

1798. **PHOSPHORUS CONTAINING AZIRIDINYL-ALCOHOL POLYMERS AND FLAME RESISTANT ORGANIC TEXTILES.** Chance, L. H.; Drake, G. L., Jr.; and Reeves, W. A. U.S. Pat. No. 2,886,538, May 12, 1959.

The production of polymeric materials from 1-aziridinyl phosphine oxide or sulfide and polyhydric alcohols. These polymeric compositions are useful for rendering textile materials flame, rot, and mildew resistant.

1791. **FLAME RESISTANT ORGANIC TEXTILES AND METHOD OF PRODUCTION.** Chance, L. H.; Drake, G. L., Jr.; and Reeves, W. A. U.S. Pat. No. 2,870,042, January 20, 1959.

The process for flameproofing textile materials. The flameproofing process employs mixed polymers produced from 1-aziridinyl phosphine oxide or sulfide and polyhydric alcohols.

1707. **BROMINE CONTAINING NITRILO METHYLOL-PHOSPHORUS POLYMERS.** Reeves, W. A.; Hamalainen, Carl; and Guthrie, J. D. U.S. Pat. No. 2,861,901, November 25, 1958.

Crosslinked liquid or solid polymers that contain phosphorus, nitrogen, and bromine in the form of stable chemical components. The polymers have utility for reducing the flammability of textiles.

1706. **FLAME RESISTANT ORGANIC TEXTILES AND METHOD OF PRODUCTION.** Reeves, W. A.; Chance, L. H.; and Drake, G. L. U.S. Pat. No. 2,859,134, November 4, 1958.

Flame-resistant polymers and the processes for producing flame-resistant textiles by use of these polymers. The polymers are produced by the reaction of 1-aziridinyl phosphine oxide or sulfide with an amino compound that has one or more radicals consisting of hydrogen or CH_2OH attached to a trivalent nitrogen atom.

1639. **PROCESS OF PRODUCING ETHYLENE OXIDE METHYLOL PHOSPHORUS POLYMERS, PRODUCTS OBTAINED AND AQUEOUS COMPOSITIONS THEREOF.** Bullock, A. L.; Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,830,964, April 15, 1958.

The ethers and the process for producing the ethers formed by an addition reaction between a phosphorus compound [tetrakis (hydroxymethyl) phosphonium chloride or tris (hydroxymethyl) phosphine oxide] and an epoxy compound (epichlorohydrin or epibromohydrin). The ethers can be polymerized and are useful for the treatment of cellulosic textile materials to produce flame resistance.

1636. **ALKENYL PHOSPHONITRILIC ESTER-POLYHALOHYDROCARBON ADDUCTS.** Hamalainen, Carl. U.S. Pat. No. 2,825,718, March 4, 1958.

Partially unsaturated phosphorus, nitrogen, and halogen containing polymeric addition products that are useful as textile treating liquids. Aqueous emulsions of these products provide particularly effective flameproofing for textiles.

1634. **CARBAMOYLETHYL, CARBOXYETHYL, AND AMINOETHYL CELLULOSE ETHER TEXTILE FIBERS AND PROCESS OF MAKING THE SAME.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,824,779, February 25, 1958.

Cellulosic textile fibers that contain carbamoylethyl radicals ($-CH_2CH_2CONH_2$), and other beta-substituted ethyl radicals, attached to oxygen atoms of cellulose and the processes for the production of these materials.

1558. **PARTIAL ACETYLATION OF COTTON FIBERS.** Keating, E. J.; Cooper, A. S., Jr.; and Buras, E. M., Jr. U.S. Pat. No. 2,816,003, December 10, 1957.

A process for the partial acetylation of cotton fibers. Cotton fibers are acetylated to a degree of substitution of from 0.5 to 2.0. Heat and rot resistance is improved thereby.

1557. **ORGANIC POLYMERIC COMPOSITIONS CONTAINING NITRILO-METHYLOL-PHOSPHORUS POLYMERS AND BROMINE COMPOUNDS.** Reeves, W. A.; Hamalainen, Carl; and Guthrie, J. D. U.S. Pat. No. 2,814,573, November 26, 1957.

Textile treating compositions containing the elements phosphorus, nitrogen, and bromine. Processes for incorporating these textile treating compositions into organic textiles in amounts sufficient to materially reduce the flammability of the treated textile.

1555. **WATER DISPERSIBLE SOLID NITRILO-METHYLOL-PHOSPHORUS POLYMERS.** Reeves, W. A.; Guthrie, J. D.; and Warren, Jane. U.S. Pat. No. 2,812,311, November 5, 1957.

Processes for the preparation of nitrilo-methylol-fibrous polymers in a reactive, water-dispersible, solid form, which solid form is stable toward polymerization during storage.

1553. **AQUEOUS EMULSION-SUSPENSION TEXTILE TREATING COMPOSITIONS AND PROCESSES OF TREATING TEXTILES WITH SAME.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,810,701, October 22, 1957.

Aqueous emulsion-suspension textile treating compositions for improving the properties of cellulosic textile materials. The resinous impregnants that are the subject of this invention impart flame resistance in addition to other desirable textile properties.

1552. **PRODUCING PHOSPHORUS CONTAINING AMINO RESINS AND FLAMEPROOFING ORGANIC TEXTILES.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. 2,809,941, October 15, 1957.

Polymers produced by the reaction of fibrous compounds of the group tetrakis (hydroxymethyl) phosphonium chloride, tris(hydroxymethyl)phosphine oxides and mixtures thereof with monomeric nitrogen compounds; processes for reducing the combustibility of fibrous organic textile materials.

1487. **ETHYLENIMINE METHYLOL-PHOSPHORUS POLYMERS AND PROCESS OF PREPARATION.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,795,569, June 11, 1957.

Crosslinked flameproof polymers and the process for producing crosslinked flameproof polymers, the liquid members of which have an unusually high water solubility and the solid members of which have unusually high hydrophilic properties and resilient spongelike structures that swell on contact with water. The polymers of this invention are produced by reacting THPC, THPO, and phosphorus-linked methylol-group-containing derivatives thereof with an ethylenimine compound. These polymers find utility in the production of flameproof textiles.

1481. **PROCESS OF PREPARING TRIALLYL PHOSPHATE-POLYHALOMETHANE POLYMERS AND PROCESS OF FLAMEPROOFING TEXTILE THEREWITH.** Weaver, J. W. U.S. Pat. No. 2,778,747, January 22, 1957.

A process for the preparation of polymeric addition products, which are the products of an addition reaction between a polymerizable trialkenyl phosphate and a polyhalomethane containing halogen atoms, and for flameproofing organic textile materials by use of the above-mentioned polymers.

1409. **AMMONIA INSOLUBILIZED METHYLOL-PHOSPHORUS POLYMERS AND CELLULOSIC MATERIALS IMPREGNATED THEREWITH.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,772,188, November 27, 1956.

A process patent for increasing the extent of polymerization and insolubility of methylol-phosphorus polymeric materials. The processes disclosed in this invention are particularly useful for insolubilizing nitrogen methylol-phosphorus polymers *in situ* as coating and impregnating materials for cellulosic materials (textiles or wood materials). The processes of this patent are particularly valuable for the application of flameproofing treatments to textiles.

1408. **PHOSPHORUS-CONTAINING POLYPEPTIDES.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,768,997, October 30, 1956.

Processes of chemically modifying polypeptides and proteins and improving their coagulation and precipitation from aqueous dispersions or solutions. The processes provided by this patent are applicable to proteins of vegetable or animal origin. Phosphorus compounds suitable for employment in the processes of this invention are tetrakis(hydroxymethyl)phosphonium chloride and tris(hydroxymethyl)phosphine oxide, mixtures thereof, and certain derivatives.

1404. **PROCESS OF REACTING AMINOALKYLATED CELLULOSIC TEXTILES WITH 8-HYDROXYQUINOLINE SULFONIC ACIDS AND METALS FORMING CHELATE RINGS AND PRODUCTS THEREOF.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,753,240, July 3, 1956.

A process for chemically modifying slivers, yarns, threads, and fabrics to produce aminoalkylated cellulosic textiles containing aryl chelate groups. The modified textiles exhibit rot resistance, ultraviolet fluorescence, and various other properties that can be imparted by metal atoms bound into the chelate groupings. Modified textiles produced in accordance with this invention exhibit a marked affinity for acid dyes.

1340. **PROCESS FOR THE CHEMICAL MODIFICATION OF COTTON SLIVER WITH SODIUM HYDROXIDE SOLUTION.** Reeves, W. A.; Corley, J. R.; and Guthrie, J. D. U.S. Pat. No. 2,751,278, June 19, 1956.

A process for the production of cotton fiber modified by chemical treatments involving the use of sodium hydroxide solutions of mercerizing strength. The process does not require the employment of complex or specialized apparatus to accomplish the modification or to process the fiber.

1338. **PHENYLAMINOALKYLATED CELLULOSIC TEXTILES AND PROCESS OF CHEMICALLY MODIFYING THEM.** Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,750,249, June 12, 1956.

A process by which aromatic radicals containing primary amino groups on the ring can be chemically bonded to molecules of a cellulosic textile without materially altering the physical properties of the textile.

1332. **PRODUCTION OF TETRAKIS(HYDROXYMETHYL)PHOSPHONIUM CHLORIDE.** Flynn, F. F.; Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,743,299, April 24, 1956.

An improved process for producing tetrakis(hydroxymethyl)phosphonium chloride (THPC). A valuable polyfunctional compound that is an intermediate for the production of numerous compounds and compositions.

1331. **FIBROUS 2-PHOSPHATOETHYL ETHERS OF CELLULOSE AND PROCESS OF MAKING THE SAME.** Chance, L. H.; Warren, J.; and Guthrie, J. D. U.S. Pat. No. 2,743,232, April 24, 1956.

A process for the production of partial ethers of fibrous cellulose in which the fibrous form and the properties it produces in textiles, i.e., hand, feel, textile strength, and the like, are retained substantially unaltered. The invention provides fibrous 2-phosphatoethyl partial ethers of cellulose and the salts of these ethers, and a process of reducing the combustibility of fibrous cellulosic materials.

1329. **PRODUCING COLORED CELLULOSIC TEXTILES.** Guthrie, J. D. U.S. Pat. No. 2,741,532, April 10, 1956.

A process for etherifying a cellulosic textile material containing hydroxyl groups with a high molecular weight color group, thus resulting in fast dyeing of the textile material.

1324. **PROCESS OF REACTING CELLULOSE TEXTILE WITH *BETA*-PROPIOLACTONE OR *BETA*-ISOVALEROLACTONE.** Reinhardt, R. M.; Daul, G. C.; and Reid, J. D. U.S. Pat. No. 2,731,323, January 17, 1956.

Beta-propiolactone reacted cellulose textile fibers produced by impregnating cellulosic textile fibers with an aqueous 5- to 50-percent alkali metal hydroxide solution; impregnating the wet fibers with a liquid, the reactive component of which consists essentially of a *beta*-propiolactone: maintaining the treated fibers at from 0° to 30° C. until the desired degree of reaction has occurred; and water-washing the fibers so treated to remove uncombined substances.

1258. **ALKALI METAL SALT OF PROPARGYL HYDROGENSULFURIC ACID AND PROCESS OF MAKING UNSATURATED CELLULOSE ETHER TEXTILES.** Parker, E. D.; and Guthrie, J. D. U.S. Pat. No. 2,727,805, December 20, 1955.

A process for making partially unsaturated ethers of cotton by reacting it with sodium allyl sulfate or sodium propargyl sulfate in the presence of sodium hydroxide.

1253. **PROCESS OF MAKING CELLULOSE FIBERS CONTAINING ETHER GROUPS AND *BETA*-PROPIOLACTONE SUBSTITUTES.** Daul, G. C.; Reinhardt, R. M.; and Reid, J. D. U.S. Pat. No. 2,724,633, November 22, 1955.

Cellulose fibers containing ether groups and *beta*-propiolactone substituents produced by etherifying cellulose fibers with an etherifying agent, such as one yielding a cellulose ether containing aminoalkyl or alkali metal carboxyalkyl radicals; and reacting the etherified cellulose fibers with beta-propiolactone.

1193. AQUEOUS HALOALKYL PHOSPHATE-AMINO RESIN FLAMEPROOFING COMPOSITIONS. Weaver, J. W.; Frick, J. G., Jr.; and Reid, J. D. U.S. Pat. No. 2,711,998, June 28, 1955.

A textile flameproofing composition comprising an aqueous solution containing (1) an ammonium salt of a polyhalopropanol acid ester of phosphoric acid selected from the group consisting of the chloro and bromo esters; (2) a water-soluble reaction product of formaldehyde with a nitrogen compound selected from the group consisting of melamine, guanidine, and urea; and (3) enough ammonium hydroxide to render the solution basic, said ammonium salt and said formaldehyde-nitrogen compound reaction product being present in the solution in the proportion of from about 0.15 to 1.0 part of the ammonium salt per part of the formaldehyde-nitrogen compound reaction product.

1078. PROCESS FOR MAKING FLAMEPROOFED DYED AMINIZED COTTON FABRICS. McMillan, O. J.; and Guthrie, J. D. U.S. Pat. 2,695,833, November 30, 1954.

A process for producing flame-resistant colored cellulosic textiles containing a laundry-resistant coloring and flammability reducing agent that is chemically bonded to cellulose molecules. Aminized cellulosic textiles containing a specified amount of nitrogen are dyed with an acid dye containing phosphato or sulfato groups, such as the dye available under the trade name Kiton Fast Red, until the textile contains a specified amount of dyestuff chemically bonded to cellulose molecules.

1076. FLAMEPROOFING AQUEOUS SUSPENSIONS OF HALOMETHYLATED PHOSPHATES. Frick, J. G., Jr.; and Weaver, J. W. U.S. Pat. No. 2,686,769, August 17, 1954.

A process for producing an aqueous emulsion flammability retarding agent that forms a laundry-resistant polymer in and on textile fibers. An aqueous emulsion containing a polyhalomethane, such as bromoform; a polymerizable unsaturated phosphate, such as triallylphosphate; an organic peroxide; and an alkali metal bicarbonate buffer is heated at a temperature at which reaction occurs, until the emulsion contains suspended particles of a halogen and phosphorus containing polymeric addition product.

1075. SUSPENSIONS OF POLYMERIC FLAMEPROOFING COMPOSITIONS CONTAINING PHOSPHATE AND HALOMETHYL GROUPS. Frick, J. G., Jr.; and Weaver, J. W. U.S. Pat. No. 2,686,768, August 17, 1954.

A process for producing an aqueous emulsion flammability retarding agent that forms a laundry-resistant polymer in and on textile fibers. An aqueous emulsion containing a polyhalomethane, such as bromoform; a polymerizable unsaturated phosphate, such as triallylphosphate; and an organic peroxide is heated at a temperature at which reaction occurs, until the emulsion contains suspended particles of a halogen and phosphorus containing polymeric addition product.

1005. PRODUCING TEXTILE CELLULOSE SULFOETHYL ETHER CATION-EXCHANGE MATERIAL. Guthrie, J. D.; Chance, L. H.; and Hoffpauir, C. L. U.S. Pat. No. 2,681,846, June 22, 1954.

A process for producing this cellulosic cation-exchange material: 2-sulfoethylated cellulosic textiles. Cellulosic textiles are impregnated with mercerizing lye solutions containing 2-chloroethane-sulfonic acid, ethionic acid, or ethylenesulfonic acid and then are cured.

1006. PROCESS FOR FLAMEPROOFING TEXTILES WITH POLY-PHOSPHONITRILIC ESTER. Hamalainen, C. U.S. Pat. No. 2,681,295, June 15, 1954.

A process for producing flameproofed textiles based on use of polyphosphonitrilic ester. Cotton textiles are impregnated with the esters produced by reacting a polyhalopropanol containing at least two atoms of the group bromine and chlorine with a mixture of phosphonitrilic chlorides in the presence of pyridine.

1007. FLAMEPROOFING FIBERS AMINOALKYLATED CELLULOSE DERIVATIVES. Reeves, W. A.; and Guthrie, J. D. U.S. Pat. No. 2,668,096, February 2, 1954.

A process for producing flameproof cellulosic textiles containing a flammability reducing agent that is chemically bonded to the cellulose. Aminoalkylating cellulosic materials are impregnated with an aqueous solution or dispersion of tetrakis(hydroxymethyl)phosphonium chloride (THPC) or a product of partially reacting THPC with a nitrogen compound such as melamine, guanidine, urea, or a methylol derivative of it; or either THPC or the product made by partly reacting THPC with a nitrogen compound along with formaldehyde; then heating the impregnated materials at from 80° to 160° C., until the aminoalkylated cellulose reacts.

937. SPINNABLE CARBOXYMETHYLATED COTTON FIBERS AND THEIR PRODUCTION. Reid, J. D.; and Reinhardt, R. M. U.S. Pat. No. 2,663,615, December 22, 1953.

A process for producing spinnable cellulosic textile fibers that are carboxymethylated to a degree rendering them water swellable or water soluble. The process is a modification of the carboxymethylation process of Patents Nos. 2,448,153 and 2,617,707 in which the cellulosic materials used are composed of spinnable fibers, the reaction of the monochloroacetic acid and sodium hydroxide to produce the desired degree of substitution is carried out in steps, and the reactants used in each step are washed away from the cellulosic material with an organic solvent so that the spinnable properties of the textile are retained.

932. FURTHER AMINIZED AMINO ALKYLATED CELLULOSE BY REACTING WITH ETHYLENIMINE. Drake, G. L., Jr.; and Guthrie, J. D. U.S. Pat. No. 2,656,241, October 20, 1953.

A process for producing cellulosic textile materials having cation-exchange properties that are retained throughout numerous use and regeneration cycles. The materials are produced by reacting an aminoalkylated cellulosic textile material containing less than about 2 percent of nitrogen, with ethylenimine, until the textile materials contain from about 2 to 5 percent of nitrogen.

862. PROCESS FOR THE PRODUCTION OF ETHYLENIMINES. Reeves, W. A.; Drake, G. L.; and Hoffpauir, C. L. U.S. Pat. No. 2,636,880, April 28, 1953.

A process to produce paraffinic ethylenimines. A basic solution of 2-aminoalkyl hydrogen sulfate (2-aminoethyl hydrogen sulfate) and alkali metal hydroxide (sodium hydroxide) containing from 25- to 50-percent dissolved materials based on the combined weight of the sulfate and hydroxides, is prepared and almost instantaneously heated to a temperature between the boiling and decomposition temperatures of the formed paraffinic ethylenimine, as by flash distillation. The ethylenimine is volatilized and then readily isolated in pure form. The process results in a high yield.

795. **PROCESS OF MAKING SOLUBLE YARNS AND THREADS OF PARTIALLY CARBOXYMETHYLATED COTTON.** Daul, G. C.; and Reid, J. D. U.S. Pat. No. 2,617,707, November 11, 1952.

A process to produce water-soluble carboxymethylated cellulose textiles by reacting a cellulosic sliver, yarn, or fabric with monochloroacetic acid in the presence of aqueous alkali, until 1 carboxymethyl group per 1 to 3 glucose units is introduced. The reactants are removed by washing with an organic solvent, such as alcohol.

794. **POLYVINYL PHOSPHORIC ACID ESTERS OF CELLULOSE AND PROCESS FOR MAKING THE SAME.** Daul, G. C.; and Reid, J. D. U.S. Pat. No. 2,610,953, September 9, 1952.

A method for the production of ion-exchange textiles, comprising textiles of fibrous cellulose esters composed of cellulose partially esterified with polyvinyl alcohol partial esters of orthophosphoric acid, in which each plurality of phosphate radicals is attached to a polyvinyl alcohol radical by single ester linkage. The textiles have a relatively high ion-exchange capacity and can be prepared in the form of cloths, fabrics, and the like, having textile properties substantially comparable to those of cotton textiles.

841. **PROCESS OF REACTING POLYVINYL ALCOHOL WITH UREA PHOSPHATE.** Daul, G. C.; and Reid, J. D. U.S. Pat. No. 2,609,360, September 2, 1952.

A process for producing novel acid esters of polyvinyl alcohol by heating an aqueous mixture of polyvinyl alcohol and urea phosphate to from 130° to 160° C. until the evolution of water vapor ceases. The esters react with cellulose derivatives and polymerize to produce high-capacity ion-exchange materials.

717. **PADDER MANGLE OR SQUEEZE ROLLS FOR IMPROVED EXTRACTION AND IMPREGNATION OF TEXTILE FIBERS, YARNS, AND FABRICS.** Keating, J. F.; and Keating, E. J. U.S. Pat. No. 2,596,152, May 13, 1952.

Rolls with a rigid, hard core covered with a layer of soft rubber from about 1/16 to 1/4 inch in thickness, having a hardness of from about 100 to 200 as measured with a Pusey and Jones plastometer using a 1/8-inch bolt. The rolls cause a markedly greater penetration of liquid into interstices and cause an unusually complete removal of liquid from fibers, yarns, and fabrics.

715. **PENTAERYTHRITOL PHOSPHORIC ACID ESTERS OF CELLULOSE AND PROCESS OF MAKING THE SAME.** Daul, G. C.; and Reid, J. D. U.S. Pat. 2,592,544, April 15, 1952.

Esters made by impregnating cellulose fibers, preferably cotton fibers in the form of a cloth, with an aqueous solution of a phosphoric acid ester of pentaerythritol or a urea or ammonium salt of such an ester, e.g., pentaerythritol or a urea or ammonium salt of such an ester, and heating the impregnated fibers to from 130° to 160° C. The esters are cellulosic ion-exchange materials characterized by an usually high free phosphoric acid-group content.

698. **COTTON FILLED STRUCTURAL MATERIAL AND PROCESS OF PREPARING THE SAME.** Busby, H. S.; and Ward, W. L. U.S. Pat. No. 2,587,-591, March 4, 1952.

Materials prepared by mixing cotton fibers; a catalytic amount of a peroxide, such as benzoyl peroxide; and a diallyl ester of a polybasic acid, such as maleic acid. The mixture is maintained at an elevated temperature until the cotton fibers swell; a polymerizable vinyl chloride resin is added and the resultant mixture is allowed to gel. The solvent is removed, and the gel is further polymerized.

714. **METHOD OF MAKING PARTIALLY CARBOXYMETHYLATED OR PHOSPHORYLATED CELLULOSIC FIBROUS MATERIALS CREASE RESISTANT AND DYE RESISTANT.** Daul, G. C.; and Reid, J. D. U.S. Pat. No. 2,584,114, February 5, 1952.

A method for impregnating the materials with an acid-polmerizable substance, such as a melamine-formaldehyde precondensate, and heating to polmerize the latter, in the absence of an added external catalyst. The method produces cloths that are free of acid-induced degradation and possess excellent hand, abrasion, resistance, and other properties.

774. **PREPARATION OF PENTAERYTHRITOL PHOSPHATE.** Daul, G. C.; and Reid, J. D. U.S. Pat. No. 2,583,549, January 29, 1952.

Novel compounds such as pentaerythritol tetrakis (diammonium orthophosphate) made by heating mixtures of pentaerythritol and urea phosphate at from about 130° to 180° C. until the evolution of water ceases. Such compounds form cellulose esters that are valuable ion-exchange materials.

719. **REDUCING THE CRYSTALLINITY OF NATIVE FIBROUS CELLULOSE MATERIAL.** Ward, Kyle. Jr.; Conrad, C. M.; and Segal, Leon. U.S. Pat. No. 2,580,491, January 1, 1952.

A method for immersing the material in certain anhydrous liquid amines, preferably ethylamine; and then removing the amino with a nonpolar solvent, which lowers the crystallinity to about 25 to 35 percent without changing the X-ray pattern of the material from that of native cellulose.

686. **SILICON-CONTAINING DERIVATIVES OF CELLULOSIC MATERIALS.** Schuyten, H. A.; Weaver, J. W.; and Reid, J. D. U.S. Pat. No. 2,562,955, August 7, 1951.

A method for producing alkylsylyl ethers of cellulose by reacting a cellulosic material with an alkylhalosilane in the presence of a tertiary amine.

594. **FABRICS OF A LONG-CHAIN AMINO-ETHOXY CELLULOSE AND THE METHOD OF MAKING THE SAME.** Reid, J. D.; and Daul, G. C. U.S. Pat. No. 2,545,492, March 20, 1951.

A method for preparing water-repellent cotton cloth or yarn by reacting amino-ethoxy cellulose with an alkyl halide, such as hexadecyl or octadecyl bromide, iodide, or chloride.

511. **PRODUCTION OF IMPROVED CELLULOSIC MATERIAL.** Reeves, R. E. U.S. Pat. No. 2,520,963, September 5, 1950.

A method for producing improved cellulosic materials by treatment with alcohol. These materials, which have low viscosity and are suitable for chemical uses, are especially resistant to reagents, particularly alkalies. The treatment is termed "alcoholysis" or, more specifically, "methanolysis" or "ethanolysis," where the alcohols employed are methanol or ethanol. A cleavage of certain linkages in the cellulose molecule occurs so that a modified cellulose is formed, containing alcohol bound in chemical union so as to stabilize the aldehyde end group.

466. PREPARATION OF FIBERS FROM CARBOXYMETHYLCELLULOSE. Reid, J. D.; and Daul, G. C. U.S. Pat. No. 2,495,767, January 31, 1950.

A process in preparing alkali-soluble fibers by extruding solutions of a soluble salt of carboxymethylcellulose into precipitating solutions. The precipitating solutions contain polyvalent metal ions that form insoluble salts with carboxymethylcellulose, such as solutions of copper sulfate, aluminum sulfate, lead acetate, stannic chloride, or mixtures of such solutions.

467. PREVENTION OF DEGRADATION OF TEXTILE FIBERS BY ACIDS. Reid, J. D.; Ward, W. K.; and Mazzeno, L. W. U.S. Pat. No. 2,493,031, January 3, 1950.

A process for impregnating textile materials, particularly cotton sewing thread for fertilizer bags, to prevent the degradation of the cellulose composing the material. The thread is impregnated with a solution of trimethanolamine. The trimethanolamine acts as both a humectant and a neutralizing agent.

400.7. STABILIZATION OF NITROCELLULOSE. Reeves, R. E.; and Giddens, J. E. U.S. Pat. No. 2,471,583, May 31, 1949.

A method of completely removing the sulfuric acid from a nitrocellulose that was nitrated in the presence of sulfuric acid. The sulfate-free nitrocellulose has a greatly improved stability. This patent is particularly directed to removing the sulfate by the addition of ammonium salts, such as ammonium sulfate, preferably to the hot reaction product. U.S. Patent No. 2,404,887 is particularly directed to an analagous removal of sulfate by the addition of ammonium hydroxide.

400.3. FIREPROOFING COMPOSITIONS. Campbell, K. S.; and Sands, J. E. U.S. Pat. No. 2,462,803, February 22, 1949.

Compositions with which cellulosic materials such as cloth can be flameproofed without an appreciable loss of flexibility, an increase of over 25 percent in weight, or a loss of more than 60 percent in permeability. The compositions consist of emulsions containing an oxide of antimony, tin or arsenic, chlorinated paraffin waxes, and a polymerizable water-soluble urea-formaldehyde condensation product. The cellulosic material is wet with the composition, and the wet cellulosic material is heated to polymerize the condensation product.

632. INTRODUCTION OF AMINO GROUPS INTO CELLULOSE. Guthrie, J. D. U.S. Pat. No. 2,459,222, January 18, 1949.

A practical process for the introduction of amino groups into cellulose textiles. The cellulose is wet with a mercerizing solution of sodium hydroxide containing about 10 percent of 2 aminoethyl sulfuric acid and heated to a temperature from 70° to 110° C. for from 40 minutes to 9 hours. After heating, the cellulose is washed to remove sodium hydroxide. Nitrogen up to about 0.6 percent is readily introduced by this procedure, and the treated fabrics dye darkly and fast with acid wool dyes.

363. METHOD OF PRODUCING COTTON CORDAGE. Goldthwait, C. F.; and Smith, H. O. U.S. Pat. No. 2,449,215, September 14, 1948.

A process for the production of heat-resistant tire cord by a modified process of mercerization. The method is particularly suitable for cotton reinforcing cord for pneumatic tires, power belts, and the like. The cotton is formed into a yarn of minimum practical spinning twist; the yarn is treated with an alkali hydroxide of mercerizing strength while it is allowed to shrink about 15 percent in length. The residual alkali is washed out with a nonacid aqueous medium, and the yarn is dried and twisted into cord.

362. PROCESS OF MAKING COTTON TEXTILES WATER-ABSORBENT AND ROT-RESISTANT. Reid. J. D.; and Daul, G. C. U.S. Pat. No. 2,448,153, August 31, 1948.

A method for partial carboxymethylating cotton cloth to produce a swellable, water-absorbent fabric that can be rendered rot-resistant. The cloth is impregnated with chloroacetic acid, treated with an alkali metal hydroxide (such as sodium hydroxide of concentrations between 20 and 50 percent), washed, and dried. The cloth can be rendered rot-resistant by treating it with a solution containing a salt of metal such as copper or mercury.

327. METHOD OF TREATING TIRE CORD. Phillipp, H. J. U.S. Pat. No. 2,444,064, June 29, 1948.

A process for producing tire cord combining high strength with desirable elongation characteristics. The strength is obtained by wetting the cotton with a swelling agent (e.g., water) and stretching it at a high temperature, so that it is stretched and dried simultaneously. This step produces a strong cord with low elongation. The cord is then re-wet and stretched without heat. The tension of the second swelling process is regulated to produce whatever elongation is desired in the finished cord.

297. COMPOSITION CONTAINING A CELLULOSE COMPOUND AND A MORPHOLIDE. Georges, L. W. U.S. Pat. No. 2,429,679, October 28, 1947.

Soluble plasticizers consisting of the morpholides of various acids, for use in cellulose acetate film-forming compositions. This patent is particularly directed to the use of the morpholides of organic acid (such as caprylic, capric, lauric, myristic, and palmitic acids). U.S. Patent No. 2,418,224 is particularly directed to a similar use of the morpholides of phosphoric acids.

296. FLAME-RESISTANT CELLULOSIC MATERIAL AND PROCESS FOR PRODUCING SAME. Georges, L. W.; and Hamalainen, Care. U.S. Pat. No. 2,428,843, October 14, 1947.

A process for the production of flame-resistant fibrous cellulosic materials. A material, such as cotton, is reacted in the dry state with a hot solution of a halogenated aryl isocyanate (such as 2,4,6-trichlorophenyl isocyanate) in a tertiary organic base (such as puridine). The reaction chemically combines the fire retardant into an integral part of the molecules of the cellulosic material. There is substantially no impairment of the fiber structure or loss in tensile strength.

263. CELLULOSE ACETATE PLASTICIZED WITH AN ARYL MORPHOLIDOPHOSPHATE. Georges, L. W. U.S. Pat. No. 2,418,224, April 1, 1947.

Soluble plasticizers, consisting of the morpholides of various acids, for use in cellulose acetate film-forming compositions. This patent is particularly directed to the use of the morpholides of phosphoric acid, and its aromatic partial esters (such as the mono- or dimorpholidophosphates or the dicresyl morpholidophosphates) that render the compositions resistant to burning. U.S. Patent No. 2,429,676 is particularly directed to a similar use of the morpholides or organic acids.

264. **APPLICATION OF CELLULOSE ETHERS TO TEXTILES.** Goldthwait, C. F.; Smith, H. O.; and Barnes, L. B. U.S. Pat. No. 2,417,869, March 25, 1947.

A method for rendering textiles resistant to attacks by micro-organisms, such as those causing molding or rotting. The textiles are impregnated with a solution of cellulose hydroxyethyl ethers in cuprammonium solution and dried. The drying renders both the ethers and the copper compounds insoluble, and they remain dispersed throughout the interstices of the textile.

231. **STABILIZATION OF NITROCELLULOSE.** Reeves, R. E.; and Giddens, J. E. U.S. Pat. No. 2,404,887, July 30, 1946.

A method for completely removing sulfuric acid from a nitrocellulose nitrated in the presence of sulfuric acid. The acid-free nitrocellulose products have a greatly increased stability. This patent is particularly directed to removing the sulfate by adding ammonia at a low temperature, preferably about room temperature. The addition of ammonium hydroxide in this manner does not require a careful control, and the time of boiling and beating necessary to remove the sulfate is not excessive. U.S. Patent No. 2,471,583 is particularly directed to an analogous stabilization by the addition of ammonium salts.

230. **METHOD OF MAKING COTTON FABRICS WITH DIFFERENTIAL ELASTIC PROPERTIES.** Goldthwait, C. F. U.S. Pat. No. 2,404,837, July 30, 1946.

A method for producing a cotton fabric that is highly elastic in one direction and only relatively elastic in the other. The fabrics are prepared by causing shrinkage by means of swelling agents and either allowing shrinkage to occur in only one direction, or allowing shrinkage to occur in both directions and then pulling the fabric back by tension in one direction. U.S. Patent No. 2,379,574 describes an analogous process for producing fabrics that are elastic in both directions.

173. **METHOD OF PRODUCING SURGICAL BANDAGES WITH IMPROVED ELASTIC PROPERTIES.** Goldthwait, C. F. U.S. Pat. No. 2,379,574, July 3, 1945.

A method for improving cotton fabric for use as a surgical bandage by the addition of elasticity. Open-weave cotton fabric is treated with a mercerizing solution of sodium hydroxide without applying tension. The resulting shrinkage imparts to the individual yarns of the fabric many small, spring-like crimps. The sodium hydroxide is removed and the fabric is dried while in the nontensioned state.

108. **COTTON YARNS FOR WATER PRESSURE HOSE.** Goldthwait, C. F. U.S. Pat. No. 2,352,707, July 4, 1944.

A method for producing cotton yarns useful in the manufacture of water-resistant fabrics, such as unlined hoses for carrying water under pressure. The yarn is impregnated with a cellulosic material that has the capacity of swelling when wet. Preferably the yarn is impregnated with an ether of cellulose, particularly hydroxycellulose.

Mechanical Processing

1894. **SELF - FEEDING AND SELF - DOFFING OPENER-CLEANER FOR TEXTILE FIBERS.** Rusca, R. A.; and Young, R. C. U.S. Pat. No. 2,893,064, July 7, 1959.

An opener-cleaner for textile fibers characterized by a hollow fiber working beater cylinder that picks up partially opened fibers without benefit of auxiliary feeding elements and releases the cleaned fibers without benefit of a doffing element.

1795. **CARDING APPARATUS.** Miller, A. L.; Brown, R. S.; and Rusca, R. A. U.S. Pat. No. 2,879,549, March 31, 1959.

A novel carding apparatus wherein the conventional revolving flats are replaced with a plurality of stationary adjacent bars or plates in the form of a cover spaced from the working cylinder. These stationary plates are secured to the flexible bend of the card and present a continuous granular or abrasive surface to the carding cylinder. This invention completely eliminates waste due to flat strips.

1790. **FIBER CLEANER.** Mayer, Mayer, Jr.; and Kotter, J. I. U.S. Pat. No. 2,867,850, January 13, 1959.

An apparatus intended for use in the separation of trash from cotton fibers. This apparatus is a variant of the device described in U.S. Patent No. 2,848,754.

1703. **FIBER CLEANER.** Mayer, Mayer, Jr.; and Kotter, J. I. U.S. Pat. No. 2,848,754, August 26, 1958.

A fiber-cleaning device particularly effective for removing trash that is heavier than the fibers, such as sticks, pepper trash, etc. The fiber cleaner is applicable to ginned cotton fibers.

1635. **FIBER CLEANER.** Kyame, G. J. U.S. Pat. No. 2,825,097, March 4, 1958.

A fiber-cleaning device having a rotatable beater cylinder that carries trash-contaminated fibers against spaced grid bars adjacent to the beater cylinder. A doffer provides for the removal of the cleaned fibers from the beater cylinder.

1554. **TEXTILE FIBER CLEANING MACHINE.** Kyame, G. J.; and Latour, W. A. U.S. Pat. No. 2,810,163, October 22, 1957.

A textile fiber-cleaning machine having a fiber recovery system for recovering portions of the fibrous material hitherto discarded. The yield of clean fiber thereby obtained is markedly increased.

1551. **THICKNESS VARIATION MEASURING DEVICE.** Martin, A. E., Jr. U.S. Pat. No. 2,805,449, September 10, 1957.

A device, combining electrical and mechanical elements, that measures and records the root mean square of the deviation in thickness of continuous lengths of material. The device may be used for various textile materials, strips, or batts such as picker laps and the like; and for strands such as slivers, rovings, and the like.

1549. **FABRIC ABRADER.** Rusca, R. A.; and Brown, J. J. U.S. Pat. No. 2,797,574, July 2, 1957.

An apparatus for determining the abrasion resistance of textile fabrics by abrading them in a manner that resembles the in-service wear of the fabrics.

1482. **COTTON OPENER.** Young, R. C.; and Rusca, R. A. U.S. Pat. No. 2,780,839, February 12, 1957.

A machine for processing staple textile fibers. The device disclosed in this invention untangles or opens tangled masses of fibers and at the same time removes a large portion of any nonfibrous particles that are mixed with the fibers.

1335. **FIBER DEFLECTOR.** Young, R. C.; and Rusca, R. A. U.S. Pat. No. 2,745,144, May 15, 1956.

An invention that provides junctions between the revolving shafts, cylinders, etc., of processing units and the walls of suction flues enclosing portions of such shafts. The junctions prevent the rotating shafts from acting on fibers to cause rolling, twisting, or nepping of the fibers, or choking due to entrainment of fibers around the shafts.

1330. **CARD CLOTHING STRIPPER.** Pettit, G. A.; and Rusca, R. A. U.S. Pat. No. 2,742,673, April 24, 1956.

A device for removing undesired impactions of fibers from the needles of card clothing. The device continuously strips the card clothing of carding machines during the carding operations.

1325. **METHOD FOR SPINNING YARN FROM STAPLE FIBER.** Kyame, G. J. U.S. Pat. No. 2,732,682, January 31, 1956.

A method and apparatus for spinning yarn strands of unlimited length from staple fibers. The invention eliminates the need for rings, travelers, spinning pots, etc., and combines the spinning and winding operations into one. The invention also provides a novel means for converting continuous rotary motion into synchronized intermittent rotary motion.

1254. **PROCESS FOR INCREASING THE BREAKING STRENGTH OF STAPLE FIBERS.** Skalkeas, B. G. U.S. Pat. No. 2,724,657, November 22, 1955.

A process for increasing the breaking strength of yarns, such as cotton yarn, by impregnating the yarns with a colloidal aqueous dispersion of silica; subjecting the wet yarns to a tension intermediate between the tension normally used in conventional procedures, such as slashing, and the breaking tension of the yarn; and drying the yarns so treated with or without tension.

1250. **FIBER CONVEYOR AND CLEANER.** Young, R. C.; and Rusca, R. A. U.S. Pat. No. 2,712,162, July 5, 1955.

A conveyor for transporting staple textile fibers comprising an endless flexible strip with a series of upward extending projections that project about ⅜ inch above the strip at an angle of about 80° at a slant opposite the direction in which the strip moves. The projections are constructed to carry the fibers along and to allow nonfibrous material to fall between them.

1191. **FIBER TESTER.** Hertel, K. L. U.S. Pat. No. 2,706,403, April 19, 1955.

The "Stelometer," a device for testing the strength and elongation-at-break of flat bundles of fibers. In the test, the fibers are held between flat-bundle clamps mounted on a frame that is arranged to fall smoothly against an air damper. The fall of the frame causes a pendulum to swing in a direction tending to pull the fiber clamps apart. The swing of the pendulum pushes indicators that record the load applied and the elongation exhibited.

1190. **NEP POTENTIAL METER.** Bogdan, J. F.; and Asbill, C. M., Jr. U.S. Pat. No. 2,698,538, Jan. 4, 1955.

An apparatus, comprising a series of contiguous cylinders covered with card clothing and rotated so that they nep staple fibers, for rapidly determining, from a relatively small sample, how much nepping can be anticipated during the processing of the fibers into card sliver.

1068. **APRON SPLICING DEVICE.** Pettit, G. A. U.S. Pat. No. 2,694,436, November 16, 1954.

A device for splicing aprons on spinning frames, etc., that is arranged so that both ends of the apron can be held in visual alinement before the clamping pressure is applied. The device consists of a frame arranged to extend above the roll of a spinning frame, clamps arranged to hold the ends of an apron that has been threaded around the roll, and a removable pressing device and backing plate arranged to press the apron ends together until they are bonded by an adhesive.

927. **ATTACHMENT FOR WEAVING HIGH DENSITY FABRICS.** Mayer, M., Jr.; and Kyame, G. J. U.S. Pat. No. 2,649,864, August 25, 1953.

An attachment that can be mounted on conventional looms to provide a means of weaving either an unusually dense cloth or an unusually uniform cloth of the usual density. The device consists basically of two horizontal stationary bars arranged across the front of the loom so that the warp strands, as they advance between the whip roll and the drop wires, pass between the bars; and one movable bar mounted in front of the other bars. Part of the strands are passed above and part are passed below the movable bar, and as the bar moves up and down in conjunction with the action of the lay sword, additional tension is applied to alternate groups of the warp strands at the moment of the beatup.

793. **FIBER DOFFING DEVICE.** Rusca, R. A.; and Young, R. C. U.S. Pat. No. 2,607,958, August 26, 1952.

A device for doffing (removing) fibrous materials (cotton) from rotating processing cylinders, such as toothed, spiked, fluted, or smooth rolls. It is especially applicable to doffing cotton from a cotton-working machine patented by this Laboratory (U.S. Patent No. 2,365,793, 1944). A toothed cylinder is so designed that it will positively engage and doff fibers from other cylinders and at the same time doff fibers from itself solely by the action of centrifugal forces. The invention eliminates the difficulties of adjustment, maintenance, and initial expense experienced by prior art that used air suction or air pressure or brushes for doffing fibrous materials.

683. **METHODS AND APPARATUS FOR DRYING SIZED OR OTHERWISE IMPREGNATED TEXTILE MATERIAL.** Rusca, R. A.; and Kyame, G. J. U.S. Pat. No. 2,578,744, December 18, 1951.

A process of drying that passes spaced impregnated textile strands through a radiant heating zone where they are exposed to rays from a gas-fired, infrared generator; controls the ratio of combustible gas to oxidizing gas supplied to the generator and to the radiant heating zone to obtain a neutral, oxidizing, or reducing atmosphere; and sucks the products of combustion into a lower temperature heating zone of reduced cross section, in which the strands move in the direction of, and in contact with, the combustion products, the strands being farther apart in the lower temperature zone.

682. **APPARATUS FOR APPLYING SIZINGS AND OTHER COATINGS.** Rusca, R. A. U.S. Pat. No. 2,564,725, August 21, 1951.

An apparatus featuring a simple means of regulating the amount of solution applied and a means for driving the rolls that eliminates stuffing boxes.

510. **METHOD OF AND APPARATUS FOR PREPARATION AND DISTRIBUTION OF SIZING MATERIALS.** Kyame, G. J. U.S. Pat. No. 2,516,884, August 1, 1950.

An improved method for the preparation and distribution of sizing materials. The unit comprises a storage tank, pump, heat exchanger, and size box so connected that the pump draws fluid simultaneously from both storage tank and size box and pumps it through the heat exchanger. The heat exchanger discharge is divided into two streams, one going back to the storage tank and the other to the size box. Both streams are made to agitate the contents of the respective tanks, and no other means of agitation is needed. To make this method more easily applicable, a novel float-type valve that controls the rate of fluid withdrawal is used to maintain a constant fluid level in the size box.

429. **METHOD AND APPARATUS FOR ELECTRICAL HEATING.** Rusca, R. A. U.S. Pat. No. 2,492,187, December 27, 1949.

An apparatus for heating textile materials by electrostatic fields created by high-frequency electric currents. The apparatus provides uniform heating and is particularly suitable for drying cotton cord used in the construction of pneumatic tires. The apparatus comprises a row of thin, flat electrodes alined to provide openings through which the material can pass and spaced apart further than the width of the electrodes. The electrodes are hinged to open to facilitate the threading of the material through them.

430. **CORD STRETCHING APPARATUS.** Young, R. C.; and Brown, J. J. U.S. Pat. No. 2,474,927, July 5, 1949.

An apparatus for stretching filaments, such as cotton cords for use in pneumatic tires, belts, and mechanical sewing threads. The apparatus consists of forward and rearward rolls about which the strand is wrapped; means for causing the peripheral speed of the rearward roll to lag behind that of the forward one; means for applying tension to the portion of the strand between the rolls; and means for causing the lag between the rolls to vary as the stretch of the strand varies.

400.6. **PHOTOELECTRIC APPARATUS FOR MEASURING LAP UNIFORMITY HAVING MEANS TO MINIMIZE TENSION ON THE LAP.** Rusca, R. A.; and Sens, C. L. U.S. Pat. No. 2,466,615, April 5, 1949.

A photoelectric apparatus for measuring the uniformity of textile mill laps in a continuous process without detrimentally affecting the layers of cotton or other fibers composing the lap. The apparatus consists of a plate provided with an opening through which beams of light are projected through the lap onto light-sensitive photoelectric cells that actuate an automatic graphic recorder. Means are provided for unrolling and rerolling the lap after it is measured.

170. **CUTTING MACHINE.** Asbill, C. M., Jr.; and Hill, G. B. U.S. Pat. No. 2,370,129, February 27, 1945.

A machine for cutting fibrous materials, such as lint cotton, into short fibers. The materials are fed into the bite of coacting series of intermeshing cutting disks turning towards each other at relatively high speeds. Each disk is a right cylinder, wide in diameter but short in height, with sharp corners, which do the cutting. The machine, although small, has a large capacity and a continuous action.

110. **COTTON-WORKING MACHINE.** Asbill, C. M., Jr.; and Young, R. C. U.S. Pat. No. 2,365,793, December 26, 1944.

A cotton working machine that breaks up large lumps of cotton into finely divided lint; feeds the lint at a relatively uniform rate into a lint flue conveyor; and facilitates the removal of trash and other foreign matter from the lumps of cotton. An endless conveyor moves the cotton towards a series of saw-toothed rolls that turn in the same direction and are arranged so that the mass of cotton is made to revolve by the action of their inner edges combined with the action of the conveyor.

107. **MATERIAL-CONVEYING FLUE.** Asbill, C. M., Jr. U.S. Pat. No. 2,344,528, March 21, 1944.

An improved air-blast conveyor-flue for conveying fibers. The flue has a longitudinal fin attached to its inside wall that inhibits the spiralling air motion that in ordinary flues causes objectionable roping and tangling of some materials such as long-staple cotton fibers. The fibers pass freely through the improved flue and are not injured by the fin.

GENERAL

Articles Outlining Cotton Research Program, Accomplishments, Aims

1809. **COTTON RESEARCH: REPORT ON PROGRESS DURING THE PAST YEAR.** Kopacz, B. M.; and Knoepfler, N. B. Cotton Gin & Oil Mill Press *60* (20): 14, 16–17, 22–25. 1959.

The cotton research program of the Southern Utilization Research and Development Division is reviewed briefly—its progress during the past year and plans for the coming year. Principal topics discussed include: PL 480 Program; Wash-Wear Research; The Granular Card; Contributions of Fundamental Research; New Finishing and Chemical Modifications; and Developments in Instrumentation and Analysis.

1842. **THE U.S.D.A. REPORTS ON THE PRESENT AND PROBABLE IMPACT OF WASH-WEAR ON COTTON AGRICULTURE.** Hoffpauir, C. L.; and Kopacz, B. M. Textile Bull. *85* (9): 31–34. 1959.

The future of cotton looks bright. Although it has lost ground in industrial markets and, in common with all textile materials, has suffered from the recent recession, it is staging a remarkable comeback in apparel and household goods. Much of the current strong market potential is due to the development of cotton wash-wear products of improved quality. The ability of the cotton textile industry to accept the challenge of wash-wear problems and to cope with them is reflected in an upsurge in sales of all-cotton minimum-care garments. However, to maintain all-cotton easy-care gains, and to establish leadership in this new market, research and industry must continue to try to perfect cotton minimum-care properties. Much progress has been made through research, and more improvements are on the way. Utilization research is the key to new and expanded markets.

1832. **PESQUISAS PARA VALORISAR O ALGODAO** (Cotton Utilization Research). Bourdette, V. R. Lanificios *10:* 304–13. 1959.

During the past two decades, synthetic fibers have offered cotton serious and constantly increasing competition based partly on price and partly on the fact that some of the synthetic fibers are better in certain applications. The United States Congress recognized the need for additional utilization research on cotton and other farm commodities to meet this increasing competition, and it enacted legislation in 1938 to establish four regional research laboratories. Cotton research carried on at the Southern Regional Research Laboratory is divided into three areas: (1) Basic research to learn more about the nature of the fiber; (2) research and development by chemical and physical modification of cotton fiber; and (3) improved methods and equipment used to process cotton fiber into textile products. As a result of cotton research, overall consumption has increased slightly during the past 10 years.

1750. CHEMURGIC RESEARCH AND ITS IMPACT ON SOUTHERN AGRICULTURE. Fisher, C. H. Filter Press (Georgia ACS Section) *14* (6): 8–16. 1959.

Establishment by the Congress of the four U.S. Department of Agriculture regional research laboratories to help solve the serious problem of crop surpluses is characterized as one of the important decisions of the age. The impact of such research on the life and economy of the country is discussed. Three industries that process southern farm crops (cotton, pine gum, and fruits and vegetables) are considered, and contributions of research at the Southern Division reviewed. Advances in the cotton industry have been greater in the past two decades than in all previous history. Chemical modifications have given cotton entirely new properties, such as wash-wear, crease retention, flame resistance, and resistance to rot, weathering, heat, oil, and soiling. Importance of new and improved machinery for textile mills such as the SRRL Opener-Cleaner, the Granular Card, and the loom attachment for weaving is discussed, together with other developments contributing to better products from cotton at lower cost. Research is credited with saving the pine gum industry of the South, an accomplishment in which developments by Dr. Charles H. Herty played an important part. Work of the U.S. Department of Agriculture Naval Stores Station, Olustee, Fla., is outlined and includes such advances as the gum precleaning process, steam distillation, the continuous still, and numerous derivatives for use of the chemical industry. Accomplishments in fruit and vegetable research include the development of frozen concentrated citrus juices; production of a satisfactory canned juice from red and pink grapefruit; increased returns to the pickle industry through a pasteurization process for the production of fresh-pack pickles; and prevention of softening spoilage of brined cucumbers.

1717. ADVANCES IN COTTON TECHNOLOGY. Knoepfler, N. B. *In* The New Intern. Year Book (Funk & Wagnalls, New York): 79–80. 1959. (Abridged version published in Universal Standard Encyclopedia Yearbook for *1958:* 61–62.)

This paper describes recent advances in cotton technology including a brief resume of wash-wear, flame resistance, water and oil repellency, ion-exchange, heat and rot resistance, and other chemical treatments. New developments in mechanical processing of cotton are also discussed.

1649. COTTON: RESEARCH PROGRESS. Knoepfler, N. B.; and Kopacz, B. M. Cotton Gin & Oil Mill Press *59* (18): 7, 8, 34–37. 1958.

The organization of SU's cotton research program is given and current research problems are discussed. Several of the most significant chemical, mechanical, and fundamental advances resulting from SU's research are briefly described. The outlook for cotton and the probable effect of research on increased utilization are presented.

1665. UTILIZATION RESEARCH AS A MEANS OF EXPANDING THE USE OF COTTON. DuPré, Mason, Jr. *In* Expanding Outlets for Agricultural Products, U.S. Dept. Agr. AMS–253: 136–41. 1958.

A report is made on current and recent research at the Southern Regional Research Laboratory on the improvement and control of the quality of cotton textile products. Summaries are also given of some closely related earlier work including: (1) Physical Properties of Cotton Fibers, Yarns, and Fabrics and their Interrelations; (2) Development of Mechanical Processing Machinery; (3) Development of Specialized Quality Characteristics in Cotton Products; and (4) Effect of Quality Improvement Research on the Consumption of Cotton.

1592. VALUE OF INTER-FIBER RIVALRY UPHELD AT TRI MEETING . . . ACHIEVEMENTS IN CHEMMOD COTTON RELATED. Fisher, C. H.; and Perkerson, F. S. Am. Textile Reptr. *72* (16): 8–10, 47. 1958.

Information presented by C. H. Fisher at the 1958 Textile Research Institute under the title "Chemical Modification of Cotton—Progress and Current Status," is summarized. Recent research on cotton and the progress made in the past decade are described. Current status of chemically modified cottons and their principal properties and uses are analyzed. Tables showing statistics on the manufacture of chemically modified cottons and their principal properties and uses; estimated costs of chemical treatment, as well as total costs; and prices of the finished product are included. Full text of the paper appears in Proceedings of the Textile Research Institute, published in the Textile Research Journal.

1647. CHEMICAL MODIFICATION OF COTTON: PROGRESS AND CURRENT STATUS. Fisher, C. H.; and Perkerson, F. S. Textile Research J. *28:* 769–78. 1958. Also: America's Textile Reptr. *72* (16): 8–10, 47. 1958. (Summary.)

Recent research on cotton and the progress made in the last decade have been described, with detailed accounts of the success of chemistry in recent years in transforming cotton into valuable new products. Current status of chemically modified cottons and their principal properties and uses have been analyzed. Tables showing percentages of the manufacture of chemically modified cottons and their principal properties and uses are included. Estimated costs of treating cotton to make chemically modified cotton as well as the total cost per pound of chemically modified cottons are also reported.

1648. CHEMICAL REACTIONS OF FIBROUS CELLULOSE. Goheen, G. E. Tappi *41:* 737–42. 1958.

Some of the work of the Southern Regional Research Laboratory and of others dealing with the application of chemistry to cotton lint has been reviewed in a general manner. While considerable accomplishments have been attained in fibrous cotton lint chemistry, much more remains to be done. However, there may be an opportunity for the beneficial application of present knowledge to the field of cotton linters for uses in specialty papers and other products.

1729. NEW FUNCTIONAL FINISHES FOR COTTON. Perkerson, F. S.; and Mazzeno, L. W., Jr. Proc. of Second Textile Seminar, Univ. Georgia. 1958. (Processed.)

Versatile as cotton fiber is, it would have fared poorly in the constantly increasing interfiber competition except for its reactivity and morphological structure, and except for research directed at the improvement of cotton textiles. Though research expenditures appear small when compared to such expenditures on products competing with cotton, vast strides have been made in imparting to cotton durable and desirable properties not provided by nature. Thus, it is possible today, through chemical modification of the cotton fiber, to produce all-cotton fabrics that are highly resistant to wrinkling or mussing, that are dimensionally stable, and that will retain creases after repeated home-type launderings. Through other chemical modification of the cotton fiber, it can be rendered permanently flame resistant or resistant to other degrading influences such as heat, microbiological attack, and solar radiation; it can be rendered highly receptive or virtually immune to certain classes of dyes: it can be given virtually any hand, from harsh and stiff to extremely soft; and it can be rendered highly repellent, not only to water, but also to oils. For some specialized uses, cotton can be made alkali- or even water-soluble. With other chemical treatments, cotton becomes sufficiently thermoplastic to be durably creased, pleated, or embossed. One promising development is chemical treatment of cotton to impart increased elasticity. Wrinkle-resistant wash-wear fabrics are only a few of the many present and potential applications for treatments of this type.

1584. **RESEARCH IMPROVES THE USEFULNESS AND ATTRACTIVENESS OF COTTON PRODUCTS.** Fisher, C. H.; and Perkerson, F. S. Joint Meeting, Cotton Improvement Comm. Tex., and Am. Soc. Testing Materials, Southwest Div. Proc. *1958:* 29–41.

Large-scale, organized research in the United States to improve and expand the utilization of cotton began in 1941 with the establishment of the Southern Regional Research Laboratory. Accomplishments since that time are reviewed in detail. Research has been aimed at two main objectives: To improve quality and lower costs of cotton for known uses, and to transform cotton into forms suitable for new and specialized uses. New instruments, such as the Stelometer and the Nepotometer, and new machinery, such as the SRRL Opener-Cleaner and the Loom Attachment for weaving high-pick fabrics, are listed. Transformation of cotton into new products is approached through chemical treatment or modification. Among the fields explored are wash-and-wear, flame resistance, soiling, and oil and water resistance. Progress and aims in these and other areas of cotton research are described.

1585. **RESEARCH POINTS WAY TO IMPROVED COTTON MARKETS—EXPANDED PROGRAM IS SAID BIG NEED.** Goheen, G. E.; and DuPré, Mason, Jr. Cotton Trade J. *38* (2): 2. 1958.

It has been predicted that in 1958 cotton research and development may be expanded along lines recommended by the 1957 report of the Presidential Commission on Increased Industrial Use of Agricultural Products (a study authorized under Public Law 540, 84th Congress). This Commission concluded that cotton should better its competitive position in relation to other fibers by improving quality and reducing production costs through a greatly expanded research and development program.

1576. **NEW CHEMICALLY MODIFIED CELLULOSE FIBERS.** Reid, J. D. Ind. Eng. Chem. *50:* 73. 1958.

This introduction to a symposium on "New Chemically Modified Cellulose Fibers" discusses the current trend toward the chemical modification of fibers already formed, such as cotton, to give them new properties desirable for specific uses. Examples given of chemical modification of cotton are treatments to impart resistance to water, to heat, or to wrinkling.

1438. **TECHNICAL ADVANCES GIVE COTTON SECOND WIND.** Fisher, C. H. Daily News Record *46:* 39, 41. March 7, 1957.

Application of research to cotton for the purpose of improving quality or reducing cost of the products is discussed. Research has resulted in wrinkle-resistant wash-and-wear or minimum-care cotton garments from resin-treated cotton, an improvement so important that these resin-treated cottons are produced in quantity greater than the total production of all the noncellulosic manmade fibers. Among other research developments mentioned are: Partially acetylated cotton, which has excellent resistance to heat and rot; and fully acetylated cotton, which, in addition to properties similar to those of the partially acetylated cotton, has greatly decreased affinity for water, and other interesting properties. By proper treatment, cotton can be given any desired degree of water absorbency, or complete water solubility. Dense fabrics can be woven by means of a special loom attachment. Various flame retardants have been developed. Slack mercerization of cotton gauze is responsible for a new commercial cotton bandage, and treatment with fluorochemicals enhances resistance of cotton fabrics to soiling and stains from water and oil.

1439. **UTILIZATION RESEARCH BY USDA HELPS COTTON TO MEET SEVERE COMPETITION.** DuPré, Mason, Jr.; and Goheen, G. E. Cotton Trade J. *37* (4): 1, 10. 1957.

Research on cotton is needed to enable this commodity to hold its position in the market against competition from many other materials, such as plastics, synthetic fibers, paper, glass, and metals. Current research progress indicates that bright prospects exist for the early commercialization of new products, processes, and equipment resulting from such investigations. Research is directed toward exploration of several areas, including improved machines for handling and processing of cotton; development of new fibers from cotton through chemical modification; and new and desirable properties for cotton, through the application of special treatments. Specific developments in each of these fields are cited, and prospects for other developments discussed.

1510. **UTILIZATION RESEARCH TO IMPROVE AND CONTROL THE QUALITY OF COTTON TEXTILE PRODUCTS.** DuPré, Mason, Jr.; Persell, R. M.; and Skau, E. L. J. Textile Inst. *48:* 453–66. 1957.

A report is made on current and recent research at the Southern Regional Research Laboratory on the improvement and control of the quality of cotton textile products. Summaries are also given of some closely related earlier work including: (1) Physical Properties of Cotton Fibers, Yarns, and Fabrics and their Interrelations; (2) Development of Mechanical Processing Machinery; (3) Development of Specialized Quality Characteristics in Cotton Products; and (4) Effect of Quality Improvement Research on the Consumption of Cotton.

1280. **CLINGING COTTON BANDAGE WITH TWO-WAY STRETCH.** Jones, M. A. Cotton Gin & Oil Mill Press *57* (4): 9, 38–39. 1956.

This is a nontechnical description of several developments in the chemical treatment of cotton told in a professional biography of the developer, C. F. Goldthwait, a pioneer in this field of cotton processing. The most important developments covered are the semielastic cotton gauze bandage, the differential dye test, partial acetylation for heat resistance, and the unlined cotton water hose.

1283. **NEW METHODS TO GIVE COTTON BETTER CHANCE ARE CONSTANTLY SOUGHT.** Goheen, G. E.; and DuPré, A. M., Jr. Cotton Trade J. *36* (3): 4. 1956. (18th Ann. Financ. and Forecast Sup.)

A process of vat dyeing and partial acetylation that greatly improves the resistance of cotton to deterioration from weathering; longer exposure-life of cotton awning fabrics, at lower cost; application of mercerization without tension to produce heavier cotton fabrics with elasticity suitable for base fabrics for plastic coatings; a highly efficient flame-retardant treatment for cotton—these are some of the processes and products that are currently being developed at the Southern Utilization Research Branch. Others are a new design of cotton carding machine; the SRRL loom attachment to produce densely woven fabrics for special uses; and a way of cleaning wall-to-wall cotton carpeting in the home. Work along other lines just being initiated is also described.

1279. **THE CHEMICAL TREATMENT OF COTTON AND WOOL.** Goheen, G. E.; and DuPré, A. M., Jr. Chem. Eng. Progr. *52* (3) : 111–14–M. 1956.

Trends pertaining to cotton and wool and the overall position of these materials in the textile market, as well as various steps in textile production, are reviewed. Special attention is given to the chemical aspects of textile operations and finishing treatments. Treatments to provide resistance to flame, water, rot, mildew, shrinkage, and creasing, and to improve fabric properties in other ways are considered. Recent developments in the chemical modification of cotton and wool to provide desirable new qualities while still maintaining the original good properties of these fibers are emphasized.

1284. **RESEARCH IS HELPING COTTON.** Fisher, C. H.; Persell, R. M.; and DuPré, A. M., Jr. Cotton Gin & Oil Mill Press *57* (1) : 7–8, 31–34. 1956.

Many practical developments in the utilization of cotton and cottonseed and new knowledge that lays the groundwork for further progress have come out of slightly more than a decade of investigations at the Southern Utilization Research Branch. Machines and methods have been developed to improve the mechanical processing of cotton. Chemical modification of cotton fiber to give it different or better qualities for special uses has resulted in some new products that have already been commercialized. Fundamental studies of the cotton fiber and its structure are revealing information that should prove valuable for further progress. Methods of processing cottonseed to produce meal and oil of better quality have been investigated; a new system for extracting oil has been developed. Studies in cooperation with State and Federal agencies have shown that properly processed cottonseed meal is suitable for feeding to poultry and swine, and changes in the chemical structure of cottonseed oil to give products with various desirable new qualities for specific requirements hold the promise of many new uses. These and other benefits are outlined in this nontechnical review of accomplishment at one of the most important centers for cotton utilization research.

1282. **EFFECTS OF CHANGES IN THE STRUCTURE OF COTTON CELLULOSE UPON THE QUALITIES OF COTTON PRODUCTS.** Scott, W. M. Textile Inst. J. *47:* 235–47. 1956.

The chief aim of this paper is to show that modern chemical techniques can be used for the improvement of the natural good qualities of cotton, and for the addition of desirable new qualities. Structural changes that can be effected by chemical action are: (1) Change of the crystal structure from the Cellulose I to the Cellulose II type by treatment with caustic soda (commonly called mercerization); (2) reduction in the degree of crystallinity in cotton cellulose by treatment with certain aliphatic amines; (3) partial esterification of the cotton cellulose with various acid anhydrides; (4) partial etherification of the cotton cellulose by treatment with various organic chemicals in alkaline solutions; and (5) treatment of cotton with chemicals capable of polymerizing within the fiber or of cross-linking with the cellulose molecule. Effects of these various treatments are described. The advancement of the science of treating cotton chemically to give it new and improved qualities cited in the paper is credited to a considerable extent for the ability of cotton to retain and even expand its markets in the face of the ever-increasing competition from manmade fibers.

1281. **COTTON PROCESSING RESEARCH—THE KEY TO IMPROVED QUALITY AND LOW COST.** Persell, R. M. Natl. Canvas Goods Mfrs. Rev. *31* (10) : 34–35, 59, 61, 63, 65, 66, 72. 1956.

This is the fourth and last of a series of articles describing cotton utilization research, published in the National Canvas Goods Manufacturers' Review. Work of the Cotton Mechanical Processing Section of the Southern Utilization Research Branch is described. Among the developments mentioned are the SRRL cotton opener, the loom attachment for weaving high-density fabrics, and a number of others for the improved processing of cotton. Leaders of the research projects are pictured and brief biographies are given. The current research program is also described briefly. Previous articles reviewed the overall cotton research program, investigations of cotton chemical processing, and fiber and fundamental investigations.

1206. **NEW TEXTILE FIBERS RESULT FROM THE CHEMICAL TREATMENT OF COTTON.** Persell, R. M. Natl. Canvas Goods Mfrs. Rev. *31* (4) : 34, 35, 60–63. 1955.

Chemical treatment of cotton to enhance its naturally excellent qualities, or to give it new qualities that will make it more suitable for additional uses, is one of the lines of cotton utilization research being pursued by scientists of the Southern Utilization Research Branch. This article describes the work of the Cotton Chemical Processing Section and identifies key research personnel. Partially acetylated, cyanoethylated, carboxymethylated, aminized, flame-resistant, and weather-resistant cotton are among the research products discussed briefly.

1205. **FIBER RESEARCH LEADS TO MORE USES FOR COTTON.** Persell, R. M. Natl. Canvas Goods Mfrs. Rev. *31* (2) : 38, 39, 52, 53, 56, 58; and *31* (3) : 45, 60, 61, 64. 1955.

The Cotton Fiber Section of the Southern Utilization Research Branch is concerned with investigations of the basic properties of the fiber, with the idea of establishing relationships between these properties and product performance. Strength and brittleness of cotton have been found to be closely related to the degree of crystallinity of the cellulose in the fiber. Other fiber properties, such as rigidity, ability to absorb moisture, and ability to resist heat and sunlight, are all related to the physical and chemical structure of the cotton fiber. Greater knowledge of these properties is expected to furnish a foundation for further improvement of cotton qualities and for greater utilization. Research leaders in the various projects are also identified.

1204. **COTTON RESEARCH AT U.S. SOUTHERN REGIONAL RESEARCH LAB.** Persell, R. M. Natl. Canvas Goods Mfrs. Rev. *31* (1) : 46, 47, 56, 69, 71, 72. 1955.

Production and manufacture of cotton provide a livelihood for more people than does any other single crop. Utilization research is a major force in efforts to strengthen the competitive position of cotton in the market, and the Southern Regional Research Laboratory in New Orleans, La., is a world-famous center of research on cotton processing and utilization. This article enumerates the lines of cotton research carried on at the Laboratory, describes the facilities, and introduces some of the personnel engaged in administration of the cotton research program there.

1208. **SRRL—WHAT IS IT—WHAT DOES IT DO—WHAT WILL IT DO?** Fisher, C. H. Textile Forum *12* (6): 8–10, 33–34. 1955.

Research on utilization of cotton as it comes from the gin comprises more than half the program of the Southern Utilization Research Branch. Research on improved mechanical processing, chemical treatment of cotton, and fundamental studies of the cotton fiber is carried out at the Southern Regional Research Laboratory in New Orleans. This article enumerates some of the beneficial developments from such research since the initiation at SRRL 14 years ago of the cotton utilization research program that resulted from work done at SRRL and other research establishments under contract with the U.S. Department of Agriculture. One indirect benefit of great potential value has been the effect of research in developing new concepts and new thinking by research men everywhere about cotton. Achievements in developing new cotton products with special qualities for specific uses open the way to still greater accomplishments in the future. The paper provides a general, nontechnical picture of this field of research.

1207. **MANY GAINS MADE OVER PAST YEAR IN THE CHEMICAL TREATMENT OF COTTON.** Guthrie, J. D. Daily News Record, October 13, *1955:* 26.

Increased interest during the year has centered on durable finishing and on chemical treatments to modify the cellulose of cotton. These newer treatments impart specific end-use properties needed to improve the competitive position of natural cotton. Some of the treatments are widely used; others are just finding their way into commercial production, while some are still in the laboratory stage. A number of these finishes or treatments, including wash-and-wear, partially acetylated cotton, cyanoethylation, rubber lattices, durable flame retardants, and other developments, are reviewed briefly in this article.

1142. **NEW COTTON PROPERTIES THROUGH CHEMICAL RESEARCH.** Fisher, C. H. Textile Research J. *25:* 1–11. 1955. Republished: Textile J. of Australia *30:* 422, 424–26, 428, 430–32. 1955.

Some of the numerous opportunities for transforming cotton—through chemistry—into new textile products have been listed. Emphasis has been given to research that attempts to select reagents and techniques that should produce new textile products having certain desired properties. While this general rational approach cannot be followed successfully in all instances because of inadequate information, it can be used successfully on some occasions. Chemical companies and other organizations are making extensive studies of the chemical modification of cotton and other cellulosic fibers. As more information is made available by these studies, it should become easier to select reagents and treatments that will transform cotton—at reasonable cost—into textile products having the particular properties needed for specific end uses. The achievement of this goal will, of course, greatly improve cotton's competitive position in the field of specialty fibers.

1034. **THE NEED FOR AGRICULTURAL RESEARCH IN THE SOUTH AND SOUTHWEST.** Fisher, C. H.; and Persell, R. M. Cotton Gin & Oil Mill Press *55* (8): 11–12, 48–52. 1954.

Research will be the basis for any sound, long-range program for agriculture and will be keynoted by cooperation among universities, industry, government research groups, and trade and commodity associations. Expectations from research; the rapid growth of industrial research as a major influence in industrial development; the story of agricultural research; the revolutionary progress of agriculture in the last 75 years in the United States; the effect of research in creating need for greater knowledge to solve new problems; the need for "balance" in agricultural research; the problem of agricultural surpluses; this country's need to adjust to worldwide changes in economic and social conditions; and research to discover entirely novel operations—these main topics are discussed. Applicability of research to the needs of the cotton industry is exemplified by such developments as the SRRL Opener, the semielastic cotton gauze bandage, and a number of other new products and processes.

1072. **RESEARCH TO TRANSFORM COTTON THROUGH CHEMISTRY INTO NEW TEXTILE PRODUCTS.** Fisher, C. H. *In* Fourth Can. Textile Seminar Proc. *1954:* 67–71. Republished: Textile Mercury and Argus *3418:* 639–40; *3419:* 686–88. 1954.

Some methods developed at this Laboratory and elsewhere for modifying cotton permanently with chemicals to create new textile products are described under these categories: (1) Treatments to effect changes in colloidal and physical properties; (2) use of fast dyes to impart new properties; (3) precipitation of insoluble materials in and on the fibers; (4) fibrous cellulose derivatives from cotton; (5) application of monomers followed by polymerization; and (6) application of polymers to cotton. Changes and improvements are effected without loss of natural fiber structure and without appreciable loss of desirable properties already possessed by cotton. New textile products include: A partly decrystallized cotton that is tougher, more extensible, and more absorbent, and that has greater dyeing capacity and greater chemical reactivity than ordinary cotton; a new type of cotton bandage of superior elasticity and clinging power; an improved cotton tobacco shade cloth; partially acetylated cotton being manufactured commercially for its heat endurance that is highly resistant to micro-organisms that cause mildew and rot; and aminized cotton, carboxymethylated cotton, and cyanoethylated cotton. Cotton cellulose has been oxidized with periodic acid. THPC has been used in conjunction with methylolmelamine to prepare products having durable flame resistance and good resistance to rotting and wrinkling resulted from cooperative research with the Office of the Quartermaster. A process comprising application of a vinyl-type monomer (essentially a bromoalkyl allyl phosphate) to cotton followed by heating in the presence of a peroxide to cause polymerization has been used on a large experimental scale to produce flame-resistant fabrics.

923.1. **THE ROLE OF BASIC RESEARCH IN COTTON UTILIZATION.** Scott, W. M. Textile Research J. *23:* 848–52. 1953.

Basic research on the structure and chemical components of the cotton fiber is fundamental to major changes in its properties. Various chemical and mechanical developments in the processing of cotton that owe their success to a background of basic research are described. Basic research has shown that brittleness of the cotton fiber is related to the degree of crystallinity. Crystallinity also affects susceptibility to dye, strength of the fiber, and other properties. Chemical modification of cotton to produce fibers and fabrics with specific properties desirable for certain special end uses, such as partially acetylated cotton, is based on fundamental information regarding the chemical structure of the cotton molecule. Even development of machines for use in textile mills, such as the SRRL Cotton Opener, stems from basic knowledge of the physical structure and behavior of the fiber under various conditions.

700. EVALUATION TOOLS IN COTTON UTILIZATION RESEARCH. Fisher, C. H. Southern Textile News *8* (6): 68, 71. 1952.

Some contributions made at the Southern Laboratory and elsewhere through research on improved use of cotton by the application of existing tools for evaluating cotton fiber, yarn, and fabric and by modifications of these tools are described.

542. NEW COTTON FIBERS BY CHEMICAL MODIFICATION. Reid, J. D. Am. Wool and Cotton Reptr. *65* (19): 27, 29, 119–21. 1951.

Although cotton has many natural advantages, it has some deficiencies that prevent it from competing successfully with other natural or synthetic fibers in certain specific fields. By chemical modification of the cellulose, it is possible to alter greatly some properties of the cotton without altering its typical fibrous form. By chemical modification is meant the transformation of all or part of the cellulose into another chemical compound. For example, by esterification or etherification cotton is made water-repellent or more water-absorbent, or rot- or flame-resistant. These and other typical reaction treatments are discussed.

628. COTTON STUDIES AT THE SOUTHERN REGIONAL RESEARCH LABORATORY. Fisher, C. H. Congrès International des Sciences Appliqués à l'Industrie Textile. *1951.* Proc., Communication Numero T14: 187–94.

Examples of research at the Southern Regional Research Laboratory on the physical and chemical structure of cotton fiber; on chemical treatments to enhance the usefulness of cotton; and on mechanical processing to develop new, improved machinery and techniques for the manufacture of cotton products are given. Information regarding the shape of the basic structural unit of cellulose has been obtained; an improved technique has been developed that uses cupriethylene diamine hydroxide solutions instead of cuprammonium as a solvent for cellulose in viscosity measurements; and the water-swelling capacity of cottons in comparison with other cellulosic fibers has been studied by use of the microscope. In chemical processing research, cotton flour and feedbags have been protected from insect penetration by treatment with pyrethrins mixed with a synergist; a simple washtub treatment making use of carboxymethyl cellulose results in cleaner and more soil-resistant cotton; and effective finishes using mineral pigments have been found for cotton shade cloth for tobacco fields. Also, by processes of aminization, phosphorylation, carboxymethylation, and partial acetylation, chemical groups can be introduced into the cellulose molecule to replace or combine with some of the hydroxyl groups. In mechanical processing research, fiber fineness has been investigated, a new draft guide has been furnished, and a new cotton opener and a new slasher have been developed. A dye test to determine cotton maturity is described which has met a specific difficulty encountered in cotton mills.

579. BACKBONE OF THE VEGETABLE WORLD. Ward, Kyle, Jr. *In* Yearbook Agr. U.S. Dept. Agr. *1950–51:* 793–97.

Cellulose, the main constituent of vegetable fibers, occurs throughout the vegetable kingdom. Its molecular structure makes it fiber forming; and, on account of its physical properties, it is one of the most useful of organic compounds. Industrial cellulose is obtained largely from wood, the textile fibers, straws, and agricultural residues. It is used unchanged for paper, pulp, and textiles. It can be modified chemically to form useful derivatives, such as cellulose nitrate, cellulose acetate, and the cellulose ethers. Since cotton is predominantly cellulose, the Southern Laboratory is carrying on a great deal of fundamental work on the basic structure of cellulose. This work includes studies of the chemical mechanism of oxidation and hydrolysis of cellulose, development of improved methods for the determination of molecular size, size distribution, degree of crystallinity, and other points of the fine molecular structure. Methods of modifying this structure to obtain improved physical properties are also being developed.

576. WHAT COTTON HAS, WHAT IT NEEDS. Scott, W. M. *In* Yearbook Agr., U.S. Dept. Agr. *1950-51:* 387–93.

Some findings in a survey by the Department of Agriculture in 1947 concerning the preferences of American housewives among textile materials are mentioned as an introduction to a discussion of the many superior qualities of cotton fabrics. Such qualities include high tensile strength, dimensional stability, good resistance to abrasion, good absorbency, and long flex life. Despite this array of excellent properties, cotton lacks inherent qualities needed for some specific uses. A study of major end-use markets made for a subcommittee of the House Committee on Agriculture in 1947 indicated that improvement is needed in 31 quality characteristics of cotton.

573. CHEMICALLY MODIFIED COTTON. Reid, J. D.; and Dean, J. D. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 405–10.

Cotton can be made more useful for certain purposes by chemical modification, that is, transformation of all or part of its cellulosic material into another chemical compound that retains the fibrous character of cotton.

568. THE UTILIZATION OF AMERICAN COTTON. Evans, R. B. *In* Yearbook Agr., U.S. Dept. Agr. *1950–51:* 377–86.

The role of cotton as the world's principal textile fiber and its position as a farm crop in the economy of the South and of the Nation are reviewed. Two primary factors in cotton consumption, quality and price, are discussed; and the outlook for cotton in view of the world situation in 1951 is considered.

477. RESEARCH IS AIDING COTTON MILLS. Fisher, C. H. Southern Textile News *6* (43): 5. 1950.

In the past few years, research conducted at the Southern Regional Research Laboratory in an effort to aid cotton mills in improving their products has included the preparation of a new draft guide for use with the high-draft type of roving frame, development of a simple dye test to distinguish mature from immature fibers, and development of a simple chemical test to detect the presence of honeydew on cotton lint. Cotton fiber and cotton chemical finishing research has been responsible for developing fabrics that have ion-exchange abilities; yarns that dissolve on being washed in soapy water, yet are strong enough to be woven; and fabrics with improved weather resistance, rot resistance, water absorbency, or soiling resistance. These developments are helping cotton to meet competition.

535. TRENDS IN THE CONSUMPTION OF FIBERS IN THE UNITED STATES 1892–1948. Meadows, Barkley. U.S. Dept. Agr. Statist. Bul. No. 89, 79 pp. 1950. (Processed.)

A statistical survey covering 56 years of textile consumption in the United States has been made that provides a convenient and comprehensive reference source on the competitive position and the relative importance of all the different fibers produced, processed, exported, imported, and consumed in the United States. The survey shows how the consumption of cotton and other textile fibers in the United States increases or decreases from year to year. Cotton is still used more than are wool, silk, flax, rayon, and all other fibers combined. Rayon and other synthetic fibers reached all-time peaks during the past 5 years.

476. **COTTON WASTE.** Dockray, G. H.; Meadows, Barkley; and Smith, Leonard. Textile Research J. *20* (10): 684–718. 1950.

The objective of this report is to present information on the size and nature of the cotton waste industry, on the factors influencing waste markets, and on methods for controlling waste; and to point out opportunities for progress in this field through research. In 1948, in the United States, the 642 million pounds of cotton waste produced had a value at the mill of $71 million. The average carded yarn mill removes as waste about 15 percent of the raw cotton; the average combed yarn mill about 30 percent. About 70 percent of the waste is fiber; the rest is similar foreign matter. About 13 percent of the total waste is used in the mill; the remainder is sold. In a typical carded yarn mill (in 1948), raw material eliminated as waste cost about 4.5 cents per pound of cotton processed, not counting labor. Research to improve the separation of fiber from the other waste ingredients, to reduce the amount of fiber removed as waste, and to improve mill testing and control measures should benefit the textile industry.

482. **INTRODUCING NEW COTTON PRODUCTS.** Kime, J. A. Proc. Eleventh Cotton Research Congress *1950:* 87–93.

The application of research to improve the competitive position and widen the utilization of cotton is illustrated by the development of superior heat- and rot-resistant cotton by a process of acetylation; the production of a new soluble cotton yarn; the treatment of cotton bagging with small amounts of pyrethrin to repel insects; the possibility of making attractive dresses, slip covers, and other products out of low-priced osnaburg finished by modern processing procedures; and the use of a new loom attachment to produce dense, tightly woven fabrics with superior resistance to wind and rain. Another example is a discovery made at the Institute of Textile Technology, Charlottesville, Va., through research performed by contract for the Department of Agriculture that cotton goods resist soiling better and wash easier when carboxymethyl cellulose is used in the rinse water.

382. **ENTER, NEW COTTON PRODUCTS.** Kime, J. A. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–229, 7 pp. 1949. (Processed.)

The theme of this paper is chemical modification of cotton cellulose to produce specific cotton products. After a brief discussion of the chemical makeup of cotton, five modifications are reviewed: Aminization, carboxymethylation, partial acetylation, oxidation, and mercerization. In each case, the process is described briefly; and the possibilities for utilizing it in the production of specific cotton products are outlined. The chemist's contribution to cottonseed research is discussed and illustrated by a resume of Southern Laboratory investigations on storage, solvent fractionation, and pigment gland studies.

387. **RECENT RESEARCH ON COTTON PROPERTIES AT THE SOUTHERN REGIONAL RESEARCH LABORATORY.** Ward, Kyle, Jr. Am. Dyestuff Reptr. *38:* 122–26. 1949.

Research by the Southern Laboratory and by contracting agencies on about 25 different properties of cotton is reviewed. The investigations are divided into three groups: Those that lead to improved methods of evaluation and testing; those that provide the fundamental data basic to further study; and those that apply the basic data to obtain specific property improvements. The incidental improvement of some properties during studies made especially to improve others, and some of the products effected by the overall improvement, are discussed.

379. **RAYON PRICES: PAST, PRESENT, AND FUTURE.** Evans, R. B. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–235, 33 pp. 1949. (Processed.)

This study has been prepared especially to provide the cotton industry with up-to-date information on the price of cotton's principal competitor, rayon. Trends on staple, yarn, and manufactured goods from rayon and from cotton are compared; and some of the factors that may influence future price trends are discussed. In addition, some data on comparative prices of other synthetic fibers are included.

386. **CHEMURGIC ADVANCES IN COTTON AND PEANUTS.** Scott, W. M. Chemurgic Digest *8* (5): 26–28. 1949.

The relationship between chemurgy and the work of the U.S. Department of Agriculture regional laboratories is emphasized, and examples of research in New Orleans that has broadened the potential industrial future of cotton and of peanuts are cited. While the overall program of the Southern Laboratory is discussed, this paper essentially is a report on progress made during the past year in research aimed at improving the economic position of these two crops in relation to that of competing products.

303. **FIBER CONSUMPTION SHOWS COTTON DOMINANCE, RAYON RISE.** Evans, R. B.; and Meadows, Barkley. Textile World *98* (3): 129, 131, 233–34, 238. 1948.

Attention is called to the main trends in total consumption of fibers in the United States during the past 50 years, as indicated by a detailed statistical study. Trends are traced individually for cotton, rayon, wool, silk, flax, jute, and the hard fibers. These show that cotton's share of the total textile market declined in recent years, while rayon and other synthetic fibers gained rapidly. However, cotton remains by far the most important fiber in the textile economy of the United States.

332. **COTTON'S INCREASING COMPETITION FROM SYNTHETIC FIBERS AND PAPER.** Evans, R. B. Proc. Fifth Spinner-Breeder Conference: 30–34. 1948. Republished: COTTON'S INCREASING COMPETITION—WHAT SHOULD BE DONE TO MEET IT. Textile Bull. *75* (3): 39–40, 42, 44, 46. 1949. Condensation: Bobbin & Beaker *7* (2): 2, 3, 16. 1949.

Information on trends in the consumption of textile fibers is brought up-to-date; and both present and prospective future competition between cotton and synthetic fibers, and between cotton and paper, are discussed in the light of existing economic conditions. Need for more research on cotton, especially of a basic nature, is emphasized.

343. **SOME RECENT DEVELOPMENTS IN COTTON RESEARCH AT THE SOUTHERN REGIONAL RESEARCH LABORATORY.** Scott, W. M. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–215, 11 pp. 1948. (Processed.) Republished: Textile Research J. *19:* 436–43. 1949. Condensation: J. of Southeastern Research *1* (2): 23–24. 1949.

The objectives of research on cotton at the Southern Regional Research Laboratory are outlined and some of the major studies described. Investigations, which seek to maintain, develop, and extend the usefulness of cotton, fall into three general classes: A search for fundamental knowledge of the physical and chemical structure of the fiber to establish a relation between basic properties and product performance; chemical finishes to enhance the naturally fine qualities of cotton and to improve other qualities in which cotton is deficient; and studies to develop new or improved machinery for more efficient and economical manufacture of high-quality cotton yarns and fabrics. Details of findings to date are given on tire cord research, weathering and rot-proofing experiments, investigations of water resistance, chemical modification of fiber and fabrics, and cotton-processing research.

304. **SYNTHETIC FIBERS AND PAPER AS COMPETITORS OF COTTON.** Evans, R. B. U.S. Dept. Agr., Bur. Ind. Chem. AIC–217, 12 pp. 1948. (Processed.)

A discussion of the current competitive situation between cotton and synthetic fibers and between cotton and paper is supplemented by six statistical tables, as follows: (1) Average estimated quantities of fibers made available for use annually by ultimate consumers in the United States during designated periods, 1892–1944, and annual totals for 1940–46; (2) Fibers made available for use by ultimate consumers in the United States during designated periods, 1892–1947, in percentages of the total; (3) Comparative prices of cotton viscose rayon staple, and acetate rayon staple, 1940–48; (4) Production of cotton and rayon tire cord and fabric in the United States, 1939–47; (5) Quantities of cotton fabric, burlap, and shipping sack paper used in bags in the United States, 1939–47, and cotton equivalents; (6) Comparative prices of cotton, burlap, and paper flour bags, per thousand, 1940–48.

535. **TRENDS IN THE CONSUMPTION OF FIBERS IN THE UNITED STATES 1892–1946.** Evans, R. B.; and Meadows, Barkley. U.S. Dept. Agr., Bur. Agr. Chem. Eng. ACE–93 (Rev.), 108 pp. 1948. (Processed.)

This report presents statistical data on consumption in the United States during the years 1892–1946 of cotton, wool, and related fibers (including mohair, camel's hair, etc.), and silk, flax, rayon, other synthetic fibers, jute, the various hard fibers, and hemp. Trends are discussed separately on the basis of mill consumption of raw fibers and of final consumption by ultimate consumers. Data on per capita consumption, exports, and imports also are presented. The body of the report contains 10 charts and about 14 key tables. In addition, there is a statistical appendix composed of 60 classified tables. Late revisions, as well as preliminary figures for 1947, are included in supplementary form.

342. **NEW DEVELOPMENTS IN COTTON—AN OLD CHEMURGIC CROP.** Scott, W. M. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–216, 10 pp. 1948. (Processed.)

The research approach to improved usefulness of cotton and cottonseed is illustrated by examples of current investigations at the Southern Laboratory. Contributions to the chemistry of cotton and of cellulose generally are cited. Chemical modifications to form new products that resist damage from mildew, sunlight, or the penetration of water are explained. The new solvent method of fractionating cottonseed is discussed and a brief description given of studies to determine the feeding value of deglanded meal and the chemical properties of pigment glands. Mention also is made of investigations of chemical treatments to lessen spoilage of cottonseed in storage.

240. **THE MARKET FOR COTTON TEXTILES IN BAGS.** Evans, R. B.; Cheatham, R. J.; and Meadows, Barkley. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–149, 14 pp. 1947. (Processed.)

Statistics are given on the consumption of cotton fabrics in bags, with comparative data on burlap and paper in this use, from 1939 to 1946; and an attempt is made to forecast what lies ahead in the bag business, assuming either high or moderate prosperity and taking into account both the effect of price and the significance of quality. Cotton's market in bags can be reinforced by increased attention to research and by promotional activities.

279. **GOVERNMENT RESEARCH WORKS HARD TO IMPROVE COTTON PRODUCTS.** Scott, W. M. Daily News Record, No. 248, Whole Number 176: 16. October 22, 1947.

Examples of research conducted at the Southern Regional Research Laboratory to improve cotton products are given as typical of the kind of research needed to extend the usefulness of cotton. A method of rotproofing by partial acetylation has been found that has proved successful in industrial trials. The water resistance of cotton fabrics has been improved by constructing them so the fibers swell and close air spaces when the fibers are wetted. A new dyeing technique that differentiates between mature and immature fibers has been developed to aid in the selection of cottons for research and manufacture. Low-grade cotton fabrics have been converted into quality products by chemical finishing.

161. **TRENDS IN FIBER CONSUMPTION.** Evans, R. B. Cotton *109* (1): 80–84. 1945.

Trends in the consumption of the textile and cordage fibers in the United States during the past 52 years are discussed. Comparative statistics are given for cotton, wool, rayon, silk, flax, jute, hemp, and hard fibers. The figures show that cotton still accounts for two-thirds of the total volume of all fibers consumed in the United States, although rayon and other synthetic fibers have made substantial advances.

88. **PHYSICS IN THE SERVICE OF SOUTHERN AGRICULTURE.** Lyons, J. W., Editor. J. Appl. Phys. *15:* 629–41. 1944.

The role of physics in research on the utilization of agricultural products as conducted at the Southern Utilization Research Branch is discussed. It is in the field of precise, objective measurement that the application of physical principles is most clearly discernible. Such measurements are used to a great extent in textile testing and research for measurement of the spun or woven products; in fundamental research on cotton fiber; and in testing of textile finishes. Spectroscopy and spectrophotometry, X-ray diffraction, electrical and optical measurements, viscosimetry, and measurements of thermal and thermodynamic properties are also used for study of a wide variety of cotton, oilseed, and fruit and vegetable products.

96. **MAINTAINING COTTON CONSUMPTION THROUGH INCREASED EFFICIENCY IN MANUFACTURE.** Cheatham, R. J. U.S. Dept. Agr., Bur. Agr. Ind. Chem. AIC–56, 8 pp. 1944. (Processed.)

The increase in domestic consumption of cotton to a peak of 11 million bales during the two World War II crop years immediately prior to July 1944 is discussed and the desirability of maintaining consumption above 10 million bales in the postwar years is emphasized. Ways of accomplishing this through increased manufacturing efficiency and improved quality of cotton products is the theme of this paper. The author points out that the textile industry has been wearing out its equipment at an unprecedented rate since the beginning of the war, and suggests that widespread installation of latest model equipment as soon as available will greatly increase efficiency. In addition, there is a steadily increasing amount of research on cotton manufacturing methods and equipment, and it appears that a number of advances in efficiency and quality are in the offing. Among these are the development of opening and cleaning equipment that will remove more trash and deliver a more uniform lap, higher speed carding, increases in output per unit of labor in spinning, and steady progress in improved weaving efficiency through increases in speed and efficiency of looms. Steps that might be helpful in developing new cotton products are also discussed and a number of examples are given.

16. **RESEARCH IN THE CHEMICAL FINISHING OF COTTON PLANNED BY THE SOUTHERN REGIONAL RESEARCH LABORATORY.** Scott, W. M. Am. Dyestuff Reptr. *30:* 604–6, 619. 1941.

Purposes and possibilities of developments in the chemical finishing of cotton to improve its properties for specific uses are described.

14. **RESEARCH PROGRAM ON COTTON UTILIZATION IN THE SOUTHERN REGIONAL RESEARCH LABORATORY.** Cheatham, R. J. Textile Bull. *58* (8) : 19–20, 38–39, 44–45. 1940.

The paper outlines the program of research on cotton at the Southern Regional Research Laboratory. The economic importance of cotton to the economy of the South, the declining cash income from the crop, and the mounting surpluses are cited as impelling reasons why such a program was undertaken. The program will embrace research to increase the utilization and value of cotton lint and cottonseed and will include industrial utilization of stalks and burrs. Research on lint will be divided into three main divisions: Fundamental research on the physical and chemical properties and structure of cotton fibers; development of new and improved cotton products and cotton processing machinery; and development and application of chemical finishes to enhance the value of cotton products. Finally, the essentials of how the research to develop new and improved cotton products will be conducted are described under the headings, selection, determination of use requirements, experiment development, and appraisal.

13. **DOMESTIC UTILIZATION OF COTTON IN RELATION TO ECONOMIC CONDITIONS IN THE SOUTH.** Cheatham, R. J. U.S. Dept. Agr., Bur. Agr. Chem. and Eng., ACE–48, 7 pp. 1940. (Processed.) (Proc. 41st Annual Convention Southern Agricultural Workers Association: 129–30. Abst.)

The importance of the cotton industry to the economy of the South from the farm through ginning and manufacturing to the consumer is emphasized. The conclusion is reached that increased outlets must be found in domestic markets if overall consumption is to be maintained. This must be accomplished through positive efforts specifically directed toward increasing cotton in industrial uses as well as in clothing and household fabrics. Research being conducted on tire cord is given as an example. A description of the work of the Southern Regional Research Laboratory includes a discussion of the research responsibilities of the three sections of the Cotton Processing Division, which will find new and extended clothing, household, and industrial uses for cotton.

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